



EN

Horizon Europe

Work Programme 2023-2024

8. Climate, Energy and Mobility

(European Commission Decision C(2023) 2178 of 31 March 2023)



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Introduction

The overarching driver for this cluster is to accelerate the twin green and digital transitions and associated transformation of our economy, industry and society with a view to achieving climate neutrality in Europe by 2050. This encompasses the transition to greenhouse gas neutrality of the energy and mobility sectors by 2050 at the latest (as well as that of other sectors not covered by this cluster), while boosting their competitiveness, resilience, and utility for citizens and society. Europe has been at the forefront of climate science and is committed to keep delivering the knowledge for enabling efficient pathways and just transitions to climate neutrality.

Activities of this work programme support the implementation of the Paris Agreement and the United Nations Sustainable Development Goals¹. By creating more jobs, accelerating economic and social transformation, faster digitalisation and by generating innovation-based and inclusive growth, activities will aid Europe's recovery² in the wake of the COVID-19 crisis, contributing directly to the Commission priorities of a European Green Deal, a Europe fit for the digital age, and an economy that works for people.

The European Climate Law³ requires the EU economy and society to become climate-neutral by 2050 in a socially fair and cost-efficient manner and, as an intermediate target, to reduce net greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels). To deliver on these targets, the Commission proposed 'Fit for 55' legislative packages in July⁴ and December⁵ 2021.

Following Russia's military aggression against Ukraine, the European Commission published the REPowerEU Communication⁶ which emphasises the need to ramp up rapidly and efficiently the clean energy transition. In line with the REPowerEU priorities, this work programme contributes to move towards the elimination of Europe's dependency on Russian fossil fuel imports by bolstering the diversification of Europe's gas supply⁷, the electrification

¹ Activities in this cluster will contribute to multiple SDGs, with the most direct impact on SDG 7 (Affordable and clean energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). In addition, SDG 3 (Good health and well-being), SDG 6 (Clean Water and Sanitation), SDG 8 (Decent work and economic growth), and SDG 12 (Responsible production and consumption) will be positively impacted.

² Europe's moment: Repair and Prepare for the Next Generation, EC COM (2020) 456 final

³ Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')

⁴ Including actions on renewable energy, energy efficiency, CO₂ emission standards for cars and vans, alternative fuels, energy taxation, and creation of a new Social Climate Fund.

⁵ Including actions on Trans-European Networks, Intelligent Transport Systems, a European Urban Mobility Framework, reducing methane emissions in the energy sector, decarbonisation of the EU gas market, energy performance of buildings, and sustainable carbon cycles.

⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A108%3AFIN>

⁷ Production and integration of renewable gas is supported in various topics of Destination 3.

of the energy system⁸ and the transformation of (energy-intensive) industries⁹. Complementary to that, the work programme supports the reduction of the transport sector's dependency from fossil fuels¹⁰.

Research and Innovation plays a central role in accelerating and navigating the necessary transitions; deploying, demonstrating and de-risking solutions; and engaging citizens in social innovation. The rate at which European research and innovation actions succeed in developing, upscaling, implementing, and commercialising innovative solutions will steer EU's future competitiveness of its existing and newly emerging industries in European and global markets.

Cluster 5 supports the EU's strategic objectives through activities included in this work programme and through the support of Institutional European Partnerships¹¹ which are implemented through dedicated structures. Although the latter activities are not included in this work programme, it is of great importance to maximise synergy and coherence between activities regardless of their implementation mode¹².

Activities in this work programme will contribute to all **Key Strategic Orientations (KSOs)** of the Strategic Plan (KSO C being the one with the most direct contribution):

- A. **Promoting an open strategic autonomy¹³ by leading the development of key digital and, enabling and emerging technologies, sectors and value chains** to accelerate and steer the digital and green transitions through human-centred technologies and innovations;
- B. **Restoring Europe's ecosystems and biodiversity, and managing sustainably natural resources** to ensure food security and a clean and healthy environment;
- C. **Making Europe the first digitally enabled circular, climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems;
- D. **Creating a more resilient, inclusive and democratic European society**, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.

⁸ More energy efficient buildings that use more renewable energy are supported in various topics of Destination 4. More performant and cost-competitive renewable energy solutions as well as their integration in the power sector is supported in various topics of Destination 2 and 3.

⁹ Energy efficiency in industry is addressed in various topics under Destination 4.

¹⁰ The use of alternative fuels for maritime transport and aviation is supported in various topics of Destination 5, the electrification of road transport is supported under Destination 2 and 5. More efficient mobility and logistic solutions are supported under Destination 6.

¹¹ Clean Hydrogen, Transforming Europe's rail system, Integrated Air Traffic Management, Clean Aviation

¹² Activities specifically targeting fuel cells and hydrogen are primarily supported through calls for proposals of the European Partnership on Clean Hydrogen. However, in justified cases and in line with topic descriptions, specific aspects of hydrogen and fuel cells can be supported outside of the Clean Hydrogen Partnership

¹³ 'Open strategic autonomy' refers to the term 'strategic autonomy while preserving an open economy', as reflected in the conclusions of the European Council 1 – 2 October 2020.

To contribute to these programme-level KSOs, cluster 5 will deliver on six specific **expected impacts**. In this work programme, each expected impact has been transformed into a specific **Destination** (see table below). This Destination-based work programme structure follows a thematic centre-of-gravity approach, but activities in a given Destination can of course have a cross-cutting character and will often contribute to multiple expected impacts. The specific contribution to the overall expected impacts is explained in the introductory text of each Destination.

Expected Impact (Strategic Plan)	Destination (Cluster 5 work programme)
Transition to a climate-neutral and resilient society and economy enabled through advanced climate science, pathways and responses to climate change (mitigation and adaptation) and behavioural transformations.	1. Climate sciences and responses for the transformation towards climate neutrality
Clean and sustainable transition of the energy and transport sectors towards climate neutrality facilitated by innovative crosscutting solutions.	2. Cross-sectoral solutions for the climate transition
More efficient, clean, sustainable, secure and competitive energy supply through new solutions for smart grids and energy systems based on more performant renewable energy solutions.	3. Sustainable, secure and competitive energy supply
Efficient and sustainable use of energy, accessible for all is ensured through a clean energy system and a just transition.	4. Efficient, sustainable and inclusive energy use
Towards climate-neutral and environmentally friendly mobility through clean solutions across all transport modes while increasing global competitiveness of the EU transport sector.	5. Clean and competitive solutions for all transport modes
Safe, seamless, smart, inclusive, resilient, climate neutral and sustainable mobility systems for people and goods thanks to user-centric technologies and services including digital technologies and advanced satellite navigation services.	6. Safe Resilient Transport and Smart Mobility services for passengers and goods

According to the **intervention logic** of this work programme, Destination 1 fosters climate science and thus helps to identify effective and efficient pathways and responses to climate change. Destination 2 supports different cross-cutting technologies and solutions for climate, energy and mobility applications. Destination 3 and 4 focusses mainly on energy issues – Destination 3 on making energy supply more sustainable, secure and competitive; Destination 4 on reducing energy demand of buildings and industry and enabling their more active role in

a smart energy system. Destination 5 and 6 improve the performance of transport modes and mobility solutions – Destination 5 increases the competitiveness and climate/environmental performance of different transport modes; Destination 6 advances mobility services and solutions at system level for passengers and goods.

Horizon Europe is the EU's research and innovation support programme in a system of European and national funding programmes that shares policy objectives. Through the programme, special attention will be given to ensuring cooperation between universities, scientific communities and industry, including small and medium enterprises, and citizens and their representatives, in order to bridge gaps between territories, generations and regional cultures, especially caring for the needs of the young in shaping Europe's future. Calls could be EU Synergies calls, meaning that projects that have been awarded a grant under the call could have the possibility to also receive funding under other EU programmes, including relevant shared management funds. In this context, project proposers should consider and actively seek **synergies** with, and where appropriate possibilities for further funding from other R&I-relevant EU, national or regional programmes (such as European Regional Development Fund (ERDF)¹⁴, European Social Fund Plus (ESF+)¹⁵, Just Transition Fund¹⁶, LIFE¹⁷, Innovation Fund¹⁸, InvestEU¹⁹, European Defence Fund (EDF)²⁰), where appropriate, as well as private funds or financial instruments. The ERDF focuses amongst others on the development and strengthening of regional and local research and innovation ecosystems and smart economic transformation, in line with regional/national smart specialisation strategies. It can support investment in research infrastructure, activities for applied research and innovation, including industrial research, experimental development and feasibility studies, building research and innovation capacities and uptake of advanced technologies and roll-out of innovative solutions from the Framework Programmes for research and innovation through the ERDF.

The EU's Recovery and Resilience Facility (RRF)²¹ – currently available in all Member States – aims at financing projects that directly tackle the economic and social impacts from the COVID-19 crisis and supports the green and digital transition. For project ideas that directly contribute to these objectives it is advisable to check access to the RRF for a fast and targeted support.

¹⁴ https://ec.europa.eu/regional_policy/en/funding/erdf/

¹⁵ <https://ec.europa.eu/esf/main.jsp?catId=62&langId=en>

¹⁶ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism/just-transition-funding-sources_en

¹⁷ <https://ec.europa.eu/environment/archives/life/index.htm>

¹⁸ <https://ec.europa.eu/inea/en/innovation-fund>

¹⁹ https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027_en

²⁰ https://defence-industry-space.ec.europa.eu/eu-defence-industry/european-defence-fund-edf_en; While focusing on civilian applications, there may be synergies with actions conducted under the European Defence Fund or its precursor programmes (Preparatory Action on Defence Research and European Defence Industry Development Programme), e.g. in the field of energy storage and management as well as innovative fuels.

²¹ https://ec.europa.eu/info/strategy/recovery-plan-europe_en

With a view to be more effective in achieving impact, proposals are expected to synergise with other relevant initiatives funded at EU level, including the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT)²². The innovation ecosystems created and nurtured by the EIT KICs (e.g. EIT Climate-KIC, EIT InnoEnergy, EIT Raw Materials) can in particular contribute to building communities or platforms for coordination and support actions, sharing knowledge or disseminating and fostering the exploitation of the project results. Where relevant, and without prejudice to the direct participation of the EIT KICs in the R&I activities under this destination, proposals are encouraged to explore other forms and means of service provisions distinct from the EIT KICs that can be complementary to the considered proposals and their activities. Collaboration with other innovation communities that can well support the project implementation and impact is also encouraged. Any such cooperation should be based on adequate intellectual property management strategies.

Research has proven that Social Sciences and Humanities (SSH) and stakeholders' involvement in the design phase of a project is pivotal to facilitate societal buy-in and long-lasting market integration of a system or technology, so they are addressed in relevant topics across the six destinations of the Cluster 5 work programme. Activities in this work programme should also pay attention to potential (biological) sex and (socio-cultural) gender differences when it comes to users' preferences and safety issues.

In this work programme, a pilot is applied to Innovation Actions implementing **co-programmed European Partnerships**, involving a **funding rate of 60%** (except for non-profit legal entities), with the aim to enhance industrial contributions. Participating topics (i.e. with a funding rate of 60%) have been selected randomly in 2023 and 2024 calls to enable analysing the effects of the lower funding rate.

Horizon Europe's approach to **international cooperation** consist of multilateralism and purposeful openness, combined with targeted actions with key third-country partners. Actions focus on aligning national, European and global efforts and investments in research and innovation areas that contribute towards achieving key European Commission priorities. With regard to cluster 5, the Commission pushes the acceleration of clean energy innovation through the Mission Innovation²³ Initiative, which was launched at COP21 and currently comprises 24 countries and the European Commission. International cooperation of EU Member States and Associated Countries in the context of Mission Innovation in relevant topics in this work programme is encouraged. In addition, this work programme specifically addresses cooperation with African countries and cooperation on sustainable decarbonisation with major emitting countries around the world, in line with the spirit of the Paris Agreement which emphasises the need for global cooperation on technology development and transfer. Legal entities established in **China** are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.

²² <https://eit.europa.eu/our-communities/eit-innovation-communities>

²³ <http://mission-innovation.net/our-work/innovation-challenges/>

For topics in this cluster, consortia could consider their voluntary contribution in terms of data, indicators and knowledge to relevant **Joint Research Centre** (JRC) platforms for capitalising the knowledge developed in their projects and become more policy relevant:

- Life cycle assessment (LCA) and its relevant application to value chain assessment: European Platform on Life cycle assessment (EPLCA, <https://eplca.jrc.ec.europa.eu/>) and making reference to the Environmental footprint method when applying LCA (<https://ec.europa.eu/environment/eussd/smgp/index.htm>);
- Raw materials: Raw materials information system (RMIS, <https://rmis.jrc.ec.europa.eu/>);
- Soil and soil related issues: European Soil Observatory (ESO, <https://ec.europa.eu/jrc/en/eu-soil-observatory>);
- The natural capital accounting: INCA platform (<https://ec.europa.eu/eurostat/ecosystem-accounts>).
- Strategic Energy Technologies Information System: SETIS (https://setis.ec.europa.eu/index_en);
- The Transport Research and Innovation Monitoring and Information System: TRIMIS (<https://trimis.ec.europa.eu/>);
- The Energy and Industry Geography Lab: EIGL (<https://energy-industry-geolab.jrc.ec.europa.eu/>).

For the purpose of the technology progress monitoring against the European Green Deal Objectives, all actions related to **hydrogen and fuel cells** funded under this work programme shall report directly or indirectly on an annual basis in a secure online data collection platform managed by the Clean Hydrogen Joint Undertaking and the European Commission. The reporting shall consist of filling in the template questionnaire(s) relevant to the project content (and the technology development and TRL).

Destination – Climate sciences and responses for the transformation towards climate neutrality

Europe has been at the forefront of climate science and should retain its leadership position to support EU policies as well as international efforts for a global uptake of climate action in line with the Paris Agreement and the Sustainable Development Goals (SDGs), including biodiversity objectives. Advancing climate science and further broadening and deepening the knowledge base is essential to inform the societal transition towards a climate neutral and climate resilient society by 2050, as well as towards a more ambitious greenhouse gas reduction target by 2030. It will involve research that furthers our understanding of past, present and expected future changes in climate and its implications on ecosystems and society, closing knowledge gaps, and the development of the tools that support policy coherence and the implementation of effective mitigation and adaptation solutions.

The activities implemented under this section will enable the transition to a climate-neutral and resilient society and economy through improving the knowledge of the Earth system and the ability to predict and project its changes under different natural and socio-economic drivers. This includes a better understanding of society's response and behavioural changes, allowing a better estimation of the impacts of climate change and the design and evaluation of solutions and pathways for climate change mitigation and adaptation and related social transformation.

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientation D** "*Making Europe the first digitally led circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems*" and the **impact area** "Climate change mitigation and adaptation".

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the "*Transition to a climate-neutral and resilient society and economy enabled through advanced climate science, pathways and responses to climate change (mitigation and adaptation) and behavioural transformations*", notably through:

- Advancing knowledge and providing solutions in the any of following areas:
 - o Earth system science;
 - o Pathways to climate neutrality;
 - o Climate change adaptation;
 - o Climate services;
 - o Social science for climate action; and
 - o Better understanding of climate-ecosystems interactions.

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- Contributing substantially to key international assessments such as those of the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) or the European Environment Agency (e.g. European environment - state and outlook reports, SOER).
- Strengthening the European Research Area on climate change.
- Increasing the transparency, robustness, trustworthiness and practical usability of the knowledge base on climate change for use by policy makers, practitioners, other stakeholders and citizens.

Coordination and synergies should be fostered between activities supported under this destination and those under other destinations of cluster 5, as well as with other clusters of Horizon Europe.

In particular, complementarities with cluster 4 and cluster 6 should be taken into account by planning for adequate resources for co-ordination and clustering activities. Following a systemic approach, this destination concentrates on activities related to climate science and modelling, whereas cluster 4 supports activities in the area of low-carbon and circular industry, and cluster 6 contributes to R&I on the implementation of climate change mitigation and adaptation solutions in the areas covered by cluster 6 (notably Intervention Area (IA) 1 on biodiversity and nature-based solutions (NBS), Earth observation, IA 4 on seas, oceans and inland waters...).

Coordination and synergies are also encouraged with the activities funded under the work programmes on the Horizon Europe missions, in particular the Mission “Adaptation to Climate Change”, the Mission “Climate Neutral and Smart Cities” and the Mission “Restore our Ocean and Waters by 2030”. While this destination supports upstream research activities on climate science, the Missions focus on the testing, demonstration and scale up of solutions to address the challenges of climate change and environmental degradation.

Actions should envisage clustering activities with other relevant ongoing and selected projects for cross-projects cooperation, consultations and joint activities on crosscutting issues and share of results, as well as participating in joint meetings and communication events. To this end, proposals should foresee a dedicated work package and/or task and earmark the appropriate resources accordingly.

Synergies are also sought throughout this destination with the work of the European Space Agency (ESA), in order to ensure complementarity and mutual benefit regarding research and innovation actions conducted at the ESA.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	

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HORIZON-CL5-2023-D1-01	107.50		18 Apr 2023
HORIZON-CL5-2023-D1-02	10.00		18 Apr 2023
HORIZON-CL5-2024-D1-01		103.00	05 Mar 2024
Overall indicative budget	117.50	103.00	

Call - Climate sciences and responses

HORIZON-CL5-2023-D1-01

Conditions for the Call

Indicative budget(s)²⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²⁵	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023				
HORIZON-CL5-2023-D1-01-01	RIA	16.00 ²⁶	Around 8.00	2
HORIZON-CL5-2023-D1-01-02	RIA	14.00 ²⁷	Around 7.00	2
HORIZON-CL5-2023-D1-01-03	RIA	8.00 ²⁸	Around 4.00	2
HORIZON-CL5-2023-D1-01-04	RIA	16.00 ²⁹	Around 8.00	2
HORIZON-CL5-2023-D1-01-05	RIA	5.50 ³⁰	Around 5.50	1
HORIZON-CL5-2023-D1-01-06	RIA	10.00 ³¹	Around 5.00	2
HORIZON-CL5-2023-D1-01-07	RIA	12.00 ³²	Around 12.00	1
HORIZON-CL5-2023-D1-01-08	CSA	3.00 ³³	Around 3.00	1

²⁴ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

²⁶ Of which EUR 9.00 million from the 'NGEU' Fund Source.

²⁷ Of which EUR 8.00 million from the 'NGEU' Fund Source.

²⁸ Of which EUR 4.00 million from the 'NGEU' Fund Source.

²⁹ Of which EUR 9.00 million from the 'NGEU' Fund Source.

³⁰ Of which EUR 3.00 million from the 'NGEU' Fund Source.

³¹ Of which EUR 5.50 million from the 'NGEU' Fund Source.

³² Of which EUR 6.50 million from the 'NGEU' Fund Source.

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HORIZON-CL5-2023-D1-01-09	RIA	8.00 ³⁴	Around 4.00	2
HORIZON-CL5-2023-D1-01-10	RIA	5.00 ³⁵	Around 5.00	1
HORIZON-CL5-2023-D1-01-11	RIA	10.00 ³⁶	Around 5.00	2
Overall indicative budget		107.50		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Earth system science

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-01: Further climate knowledge through advanced science and technologies for analysing Earth observation and Earth system model data

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

³³ Of which EUR 1.50 million from the 'NGEU' Fund Source.

³⁴ Of which EUR 4.00 million from the 'NGEU' Fund Source.

³⁵ Of which EUR 2.50 million from the 'NGEU' Fund Source.

³⁶ Of which EUR 5.50 million from the 'NGEU' Fund Source.

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).³⁷.</p> <p>Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.</p>

Expected Outcome: Actions are expected to contribute to **all of the** following outcomes:

- Better knowledge of the past, present and future of the Earth System, relevant for regional or international assessments like those of the IPCC.
- Support to the development of targeted and cost-efficient climate mitigation or adaptation strategies in Europe.
- Advanced data science capacities and skills for climate data analysis, capacity building and training.
- Lasting cooperation between Earth System research, Earth Observation data providers, Data science and high-performance computing (HPC) infrastructures.

³⁷ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Scope: The EU and its Member States have invested massively in Earth Observation (EO), for example with the Copernicus Programme, the development of climate and Earth System Models (ESMs), and their contribution to the implementation of Global Earth Observation System of Systems (GEOSS), which are yielding unprecedented volumes of data. This topic aims at spurring the exploitation of these assets through advanced data technologies, including artificial intelligence techniques like machine learning or explainability, or new statistical approaches based on the cooperation between “big data” engineers, EO specialists and climate scientists.

Actions should create new insights in key processes of the Earth system and improve climate predictions based on advanced exploitation of EO data and their appropriate integration in existing or new data assimilation or modelling approaches. The activities should also lead to improved evaluation tools to facilitate the analysis of ESMs by developing new process-oriented diagnostics to better understand remaining biases and drifts, or unresolved processes or coupling in models, and improve model parameterisation and tuning. Actions should develop new tools or approaches to increase the efficiency (i.e. speed) in analysing model outputs to facilitate the study of such vast amounts of data. Actions should also distil more tailored, usable and reliable information from models and observations for assessing risks caused by extreme weather and climate events in Europe in the coming decades and contribute to an improved detection of climate change on varying space and time scales.

Actions should build on the results of, and cooperate with, past and ongoing scientific research related to EO and ESMs³⁸, as well as adaptation strategies at global and regional levels, e.g. the science base supporting the Copernicus Services, ESA data cubes, the relevant action within the GEO multiannual WP, the EuroHPC JU investments in HPC capabilities or Destination Earth.

When dealing with models, actions should promote the highest standards of transparency and openness, going well beyond documentation, as much as possible, and extending to aspects, such as assumptions, code and data that is managed in compliance with the FAIR principles³⁹. In particular, beneficiaries of EU funding are required to publish results data in open access repositories and/or as annexes to publications, and provide full openness of any new modules, models or tools developed from scratch or substantially improved. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2023-D1-01-02: Climate-related tipping points

Specific conditions

³⁸ E.g. projects [NextGEMS](#), [ESM2025](#) and projects funded under the call [HORIZON-CL5-2022-D1-02-02](#)

³⁹ FAIR (Findable, Accessible, Interoperable, Reusable).

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).⁴⁰.</p> <p>Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.</p>

Expected Outcome: Actions are expected to contribute to **all of the** following outcomes:

- New or improved models for climate predictions or projections, which take into account climate-related potential tipping points and their impacts and are relevant for major assessments like those of the IPCC and IPBES.
- Better understanding of potential compound or cascading effects on climate, ecosystems and society as a consequence of crossing specific tipping points.
- Increased capacity to identify unknown tipping elements and early warning signals when a tipping point is approached.

⁴⁰ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Contribution to mitigation policies with view to the Paris Agreement and the EU Biodiversity Strategy 2030, taking into account the precautionary principle, with respect to abrupt responses, hysteresis and other non-linear behaviour of the Earth system.
- Input to adaptation strategies for the most affected regions, globally, addressing the risks of crossing climatic tipping points and related impacts on ecosystems and biodiversity.

Scope: Elements of the Earth system, including ecosystems, can suffer relatively rapid transitions in response to small changes in forcings, a process known as crossing a tipping point. Such transitions are often irreversible: the system does not return to its original state even when the forcing that caused it is brought back to its original value. The transition to a new state would have a high (even catastrophic) impact across multiple regions, physical processes, ecosystems and biodiversity, and should therefore be avoided (in line with the EU's biodiversity strategy for 2030). Some of these tipping points may have already been crossed or have a high probability of being crossed during this century, like those caused in the ocean by warming, acidification and deoxygenation. Early warning signals, reversibility, hysteresis and resilience should be addressed through appropriate analysis methods. Mitigation pathways and safe operating spaces for humanity should be assessed and communicated to targeted audiences.

The ability and/or sensitivity of global Earth system models (ESM) to simulate tipping point crossings and other non-linear behaviour requires solid process understanding, firmly rooted in observational evidence, including from paleo-records. These processes need to be correctly represented in ESMs. The probability and impact of tipping point crossings and abrupt system changes need to be better quantified for a sound risk analysis (including aspects of irreversibility), addressing for example impacts on agriculture, fisheries, or health. Further, the approach to and crossing of tipping points lead to a loss of ecosystem resilience, causing a compounding effect in ecosystems already stressed due to non-climatic factors, and the potential for cascading impacts across trophic webs and ecosystems.

Projects should build on the results of and cooperate with, past and ongoing scientific research related to tipping points, abrupt ecosystems change and potential mitigation and adaptation strategies at global and regional levels.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁴¹. In particular, beneficiaries are strongly encouraged to publish results data in open access repositories and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Finally, projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

⁴¹ FAIR (Findable, Accessible, Interoperable, Reusable).

HORIZON-CL5-2023-D1-01-03: Climate impacts of a hydrogen economy

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: The objective of this topic is to achieve greater understanding among policy makers and stakeholders of the climate impact of large-scale deployment of hydrogen as an energy carrier or industrial feedstock, and options for addressing it. This will inform policy makers in the context of the European Green Deal, as well as alerting actors in the private sector to the environmental risks, including water and land use, opportunities and co-benefits associated with a hydrogen economy.

Actions are expected to contribute to **all of the** following outcomes:

- A rigorous assessment of the behaviour of hydrogen in the oxidizing cycles of the atmosphere related to methane, water vapour, carbon monoxide and ozone.
- A rigorous assessment of the ways in which large-scale production, distribution and use of hydrogen (e.g. as an energy carrier or industrial feedstock) can affect anthropogenic radiative forcing.
- Better monitoring tools (methodologies and instruments) for detecting and quantifying hydrogen leakage (in situ or through remote sensing).

In each case, it will be necessary to consider direct and indirect radiative forcing, both from hydrogen (e.g. potential leakages) and from other forcers associated with, or displaced by, its production, its transport and consumption.

Scope: Successful consortia should conduct **all of the** following activities:

- To provide a better knowledge in order to achieve deeper and more precise understanding of the overall mechanisms driving the hydrogen cycle and its future

development under concentrations higher than historically observed (with a specific focus on hydrogen sink processes).

- Thorough analysis of the radiative forcing impacts of hydrogen, specifically by investigating the mechanistic interactions of hydrogen with tropospheric gases, in particular methane, carbon monoxide, nitrous oxide and the potential to increase atmospheric water vapour.
- Assessment of **all of the** following aspects:
 - Direct and indirect effects in the atmosphere and their environmental implications (e.g. on the ozone layer).
 - The potential of systems, technologies and markets associated with large-scale hydrogen deployment to alter atmospheric hydrogen concentrations.
 - The channels through which large-scale deployment of hydrogen could reduce global warming (e.g. by replacing fossil fuels or storing energy to balance intermittent sources of renewables).
 - The channels through which large-scale deployment of hydrogen could contribute to global warming (e.g. through leakages in the supply chain, efficiency of production and conversion processes, creation of a market for natural gas, decommissioning, displacement of other low carbon technologies).
 - Options for mitigating any global warming risks associated with hydrogen deployment (e.g. through leakage detection technologies).

Proposals are also invited to:

- Identify any significant non-climate co-benefits or side effects of hydrogen deployment (e.g. on air, soil and water quality, as well as water resource availability).
- Consider the extent to which the risks of climate impacts from hydrogen deployment vary between different uses (e.g. energy, industry, transport).
- Consider opportunities for mitigating such risks.
- Disseminate their findings to relevant stakeholders such as national public authorities and the European Clean Hydrogen Joint Undertaking.

Projects are encouraged to seek, during their lifetime, collaboration with possible complementary projects funded by the Clean Hydrogen Joint Undertaking on determination of hydrogen releases from the H₂ value chain.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects

such as assumptions, code and data that is managed in compliance with the FAIR principles⁴². In particular, beneficiaries are strongly encouraged to publish results data in open access databases and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

HORIZON-CL5-2023-D1-01-04: Improved knowledge in cloud-aerosol interaction

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ⁴³ Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

⁴² FAIR (Findable, Accessible, Interoperable, Reusable)

⁴³ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Expected Outcome: This activity is expected to enhance our understanding of the cloud-aerosol interactions and their impacts in the Earth system and to include developing advanced algorithms as well as high-resolution models to better reproduce realistic cloud phase and structures, its interactions with different types of aerosols and their radiative impacts.

Project results are expected to contribute to **all of the** following outcomes:

- Enhanced large community effort in Europe to bring together the latest advances in science, modelling, in situ, ground-based, oceanic, and airborne remote sensing as well as satellite observations to tackle the complex cloud-aerosol interactions.
- Improved Earth systems models and better long-term climate projections, and/or climate prediction, in particular at seasonal and decadal time scales.
- Better understanding of convective systems leading to improved predictions of extreme events.
- Reduced uncertainties in climate models through a better representation of cloud formation, aerosol-cloud interaction, and their combined radiative properties.
- Use and assimilation of aerosol and cloud products from novel satellites (e.g. Earth CARE⁴⁴, MetOp-SG⁴⁵) for climate model improvement and validation and/or weather predictions.
- Contribution to IPCC assessments and other outputs by addressing this major knowledge gap in the Earth system and important source of uncertainty in climate models.

Scope: The challenge of this topic is to improve the representation of cloud life cycle, aerosol-cloud interactions and chemistry, cloud vertical structures, and the radiative properties of the various aerosol and cloud types that is the largest source of uncertainty in today's climate models, and represent an important knowledge gap in Earth system and climate science, and in the Earth radiation budget in particular. This requires better understanding of multiple scattering of radiation within the three-dimensional structure of clouds and different direct and indirect effects of aerosols on radiative transfer. It will lead also to a strengthened understanding of mechanisms through which clouds and aerosols significantly modify the planetary albedo and Earth-radiation budget. The science of cloud formation and its impact on climate should be advanced through an integrated use of in situ and satellite observations in high-resolution models which reproduce realistic cloud structures and their radiative properties.

The projects should address this challenge through:

- Making use of new and existing, in situ and satellite measurements, including reanalysis, new parameters such as water isotope composition, and laboratory experiments, in

⁴⁴ [EarthCARE - Earth Online \(esa.int\)](https://earthcare.esa.int/)

⁴⁵ [Metop - Second Generation | EUMETSAT](https://www.eumetsat.eu/)

combination with new analysis methods, to advance the scientific understanding of the complex interactions between aerosols, clouds and climate at a fundamental level.

- Developing novel descriptions of fundamental sub-grid scale aerosol and cloud processes in Earth System models to better represent the radiative and precipitation properties of various aerosol and cloud types in the models.
- Linking aerosol and cloud processes to hydrologic cycle and advancing understanding of their role for evaporation and precipitation in nature and models.
- Enhancing the systematic and coordinated collection and use of ground-based or airborne observing systems from relevant existing networks (e.g. Earlinet, Aeronet, ACTRIS). These datasets will also be critical to enhance satellite retrievals and validation of cloud and aerosols parameters.
- Coordinating with the satellite community where needed e.g. Metop-SG, especially for supporting the validation needs of new missions such as ESA's EarthCARE.
- Establishing in the course of the projects wide-open access to the observation data produced within relevant measurement network databases (e.g. ACTRIS).
- Contributing to assimilation of cloud data in climate models from the "40 years" record of satellite data available and other means of cloud observations.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Atmosphere Science Cluster⁴⁶ and relevant ESA activities related to the use of the EarthCARE mission.

Proposals should address the collaboration with ongoing or future ESA Atmosphere Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁴⁷. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under

⁴⁶ <https://eo4society.esa.int/communities/scientists/esa-atmosphere-science-cluster/>

⁴⁷ FAIR (Findable, Accessible, Interoperable, Reusable).

the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

Climate change mitigation, pathways to climate neutrality

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-05: Science for successful, high-integrity voluntary climate initiatives

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.50 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- Recommendations, guidance and capacity building to help governments and non-state actors ensure high integrity in voluntary climate change mitigation initiatives through enhanced evaluation, design, implementation and monitoring.
- Helping to translate scientific consensus and knowledge (e.g. IPCC reports) and government commitments (e.g. under the Paris Agreement), into meaningful corporate and other non-state climate strategies and actions.

- Contribution to the implementation of the Paris Agreement and the European Green Deal through support to development and scaling up of high-quality voluntary initiatives that deliver genuine climate benefits in Europe and globally.
- Development of a standardised framework for the assessment of carbon offsetting schemes.
- Reducing risks of greenwashing, including in the use of offsets, and also of technology-lock-ins.

Scope: To meet the goals of the Paris Agreement global GHG emissions should reach “net-zero” by mid-century and be halved by 2030 compared to current levels. This requires immediate, rapid and large-scale emissions reductions across all sectors of the economy. Voluntary initiatives and pledges by non-state actors, such as the private sector, financial institutions, civil society, cities and subnational authorities could help fill the gap, mobilise finance and accelerate the transformation process. However, the integrity-related concerns of these actions must first be overcome and require better understanding of the actual climate impacts and other potential side-effects.

This action should advance the knowledge about the role of voluntary initiatives in achieving the objectives of the Paris Agreement and the European Green Deal, including consistency and interactions with global/national government commitments, regulated markets and between each other. It should address barriers and weaknesses associated with voluntary initiatives, such as inconsistency of definitions and claims (e.g. net-zero, carbon positive, carbon negative, climate neutral, etc.), their environmental integrity, fragmentation, complexity, poor measurement, verification and reporting practices as well as concerns related to additionality, double counting, transparency, governance, and accounting of the wider social and ecological consequences.

The action should evaluate the role of compensation schemes in voluntary climate initiatives, and the implications for transition pathways. To this end, it should improve the understanding of the impacts of carbon offsets, assess their risks and limitations, investigate how offsets affect and interact with other emission abatement options, and under which conditions they could accelerate cost-effective mitigation. It should analyse the scientific integrity of various existing offsetting schemes, identify their strengths and weaknesses and develop clear scientific guidance about their proper use to safeguard climate-positive outcomes. This should include identification of synergies and avoidance of trade-offs with other policy objectives, such as biodiversity related ones, and full respect of the “do no significant harm” principle. Any promotion of offsetting schemes is out of scope of this call.

The action should also explore and assess different options for improved monitoring, reporting and verification of various voluntary climate initiatives, including through leveraging of satellite-based earth observation such as Copernicus/ Galileo/EGNOS.

Finally, it should enhance the modelling tools and integrated assessment frameworks to better integrate voluntary climate initiatives into transition pathway analysis and to address the specific needs of non-state actors (but not necessarily with a single model/tool).

Co-creation with various stakeholders in the private and public sectors, including actors from developing countries, is expected under this action to ensure that the outcomes produced remain relevant for the end-users.

Actions should envisage clustering activities with other relevant ongoing and selected projects for cross-projects cooperation and exchange of results, including as participation in joint meetings and communication events.

HORIZON-CL5-2023-D1-01-06: Broadening the range of policy options in transition pathway analysis

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- A broader range of policy options that reflect different visions of sustainability and resilience based on alternative economic, technological and societal futures and reflecting different perspectives from economics, (other) social and natural sciences.
- Assessment of long-term feasibility of reconciling economic growth with climate and other environmental objectives and consequences for mitigation pathways.
- More comprehensive understanding of the implications of Paris Agreement-aligned transformation for other (than climate) environmental thresholds and social outcomes, including equity, fairness and justice, as a basis for fostering synergies between climate action and other policy goals such as those embedded in the Sustainable Development Agenda.
- Increased diversity of frameworks and scenarios used in climate change mitigation modelling.
- Enhanced assessments of 1) energy and material demands and their links to the macro-economy, 2) behavioural and lifestyle changes, including sufficiency measures and their representation in integrated assessment models and 3) circular economy approaches to decrease the use of energy and materials.
- Development of knowledge to inform future major international scientific assessments such as reports by IPCC and IPBES.

Scope: There is an urgent need for a new paradigm that reconciles continued development of human societies with the maintenance of the Earth system in a resilient and stable state. Meeting the ambitious goals of the Paris Agreement while simultaneously respecting other environmental and social constraints would require not only rapid reductions of GHG emissions and other climate forcers, but also decoupling of economic output from material throughput, pollution and biodiversity loss. However, empirical evidence demonstrates a strong relationship between economic growth (expressed in GDP terms) and GHG emissions, energy use, demand for raw materials, land and other natural resources, as well as pollution. Projections indicate that, with existing growth trajectories, absolute decoupling on the scale required could prove extremely challenging.

Actions should advance knowledge on the feasibility of the green growth paradigm in the context of transition to climate neutrality, including improved understanding of underlying challenges and opportunities, and by building on the latest scientific evidence. They should explore alternative (to growth-oriented) socio-economic scenarios (such as, but not limited to, degrowth, postgrowth, or “Doughnut” economic models) which could support the transition to climate neutrality. Research should look well beyond general concepts and explore (where possible quantified) the practical implications, benefits, barriers, conditions for delivering strong social outcomes and feasibility of pursuing such alternative options as a viable policy choice within the EU and beyond. In their work, actions should examine the role of emerging/potential trends (such as digitalisation, circularity, structural changes in the economy, relocalisation of value chains), geopolitical events and shifts in societal values (e.g.

COVID related) in shaping future socio-economic development and assess their impacts on the achievement of climate policy objectives. The analysis should also account for the accelerating impacts of climate change and embrace interlinkages with other policy goals, notably biodiversity, resource conservation and human development related. Building on these results, actions should draw conclusions for Nationally Determined Contributions (NDCs) and long-term strategies under the Paris Agreement.

Actions should address some of the following aspects in their research:

- Improve the understanding of the dynamics between economic growth and energy, materials' use, pollution and land demand. This could include assessing whether shifts within a GDP-based system, such as a greater share of services and recognition of household labour in national statistics, affect the degree of compatibility of economic growth with climate and biodiversity goals.
- Advance knowledge about the role and potential of lifestyle changes and sufficiency-oriented measures in the overall strategies towards climate neutrality and in the context of other environmental goals, improve their quantification and representation in modelling frameworks and explore the socio-economic, cultural, institutional, infrastructural, regulatory and other conditions for scaling-up.
- Identify and explore the main barriers to adoption of alternatives to growth-based economic models. For example: How plausible is it for policy makers to embrace them? Are there real-world examples? Can a region such as Europe pursue alternative approaches unilaterally?
- Assess the relationship between continued economic growth and societal well-being. Investigate alternative approaches to delivering social progress and evaluate the well-being outcomes of measures to transform societies towards climate-neutrality, taking into account distributional and equity related considerations as well as a broad range of well-being indicators and differences between social and economic groups.
- Investigate how alternative economic approaches could be explained to and accepted by citizens and businesses concerned about both climate and their livelihoods/operating conditions. For example, which concrete day-to-day changes would be required? What are the implications for living standards? How would professions work? What dis-/incentives would firms face to compete, expand and innovate?
- Assess the risks of disruption to energy, food and other key commodity markets based on alternative future transition pathways and development paradigms.
- Explore potential future development paradigms in both high-income and developing economies, taking into account fairness dimension, and evaluate implications for the transition process towards climate neutrality.

The projects are expected to take a truly interdisciplinary approach, leveraging natural, economic and other social sciences to inform policies capable of delivering on multiple

environmental, economic and social objectives simultaneously while taking into account constraints related to feasibility and acceptability.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond model documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁴⁸. In particular, beneficiaries are strongly encouraged to publish data and results in open access databases and/or as annexes to publications.

Successful proposals should establish synergies with the projects resulting from the topic [HORIZON-CL5-2021-D1-01-02: Modelling the role of the circular economy for climate change mitigation](#)⁴⁹ as well as with the future project resulting from the topic “HORIZON-CL5-2024-D1-01-06: The role of climate change foresight for primary and secondary raw materials supply” as regards implications for resource demand and the associated GHG emissions.

This topic requires the effective contribution of SSH disciplines (e.g. sociology, economics, behavioural sciences, gender studies, etc.) and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Climate change impacts and adaptation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-07: Modelling for local resilience - Developments in support of local adaptation assessments and plans

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

⁴⁸ FAIR (Findable, Accessible, Interoperable, Reusable).

⁴⁹ <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl5-2021-d1-01-02>

	additionally be used).
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Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- Support to the implementation of the EU Strategy on Adaptation to Climate Change and the Mission on Adaptation to Climate Change, by enabling better informed adaptation plans and strategies at the regional and local level.
- Strengthen science-based decision-making when it comes to resilience and disaster risk management, including on the role of nature-based solutions.
- Stronger local adaptive capacity.
- Improved synergies between national, regional and local Green Deal objectives, in particular adaptation action.
- Better coordinated and more impactful R&I activities on adaptation modelling and risk assessment.

Scope: The EU strategy on Adaptation to Climate Change⁵⁰ stresses the need to increase local resilience, as one of its key implementation actions. The Horizon Europe Mission on Adaptation to Climate Change has been launched in September 2021 with the aim to support at least 150 European regions and communities to become climate resilient by 2030. Yet resources and tools to address adaptation at the local level are often scarce. To improve the support to local adaptation action it is essential to increase the availability, reliability, accessibility and resolution of climate information, in combination with non-climatic natural and anthropogenic drivers, at local and regional scale considering local specificities.

Therefore, actions should:

- Develop and test user-friendly high-resolution climate physical risk assessments models. This could include improvements in data acquisition, modelling, tools and methods to increase resolution of global climate models and regional climate models in combination with local natural and anthropogenic stressors that underpin risk assessment modelling. Utilize and test relevant resilience models and assessment methods developed in previous R&I programme projects (including FP7 and Horizon 2020).
- Consolidate information and data on cost and effectiveness of adaptation actions (including from FP7 and Horizon 2020 projects⁵¹) at local level, in particular actions that integrate both adaptation and mitigation and in particular nature-based solutions that address both biodiversity and climate crisis. Carry out work to close the remaining knowledge gaps, particularly in bridging climate models with other earth system (natural and anthropogenic) processes. This should also feed into the knowledge basis of the

⁵⁰ COM(2021) 82

⁵¹ Including projects under topic HORIZON-CL5-2022-D1-02-04: Supporting the formulation of adaptation strategies through improved climate predictions in Europe and beyond

Mission on Adaptation to climate change and be made available to all EU regions and communities. This work could include improvements in modelling, the design of adaptation pathways and other relevant tools in this domain.

- Facilitate quick access and operational guidance to knowledge from adaptation – including:
 - Economic and social implications associated to climate risks.
 - Cross-sectoral impacts of climate change and their associated uncertainties.
 - The cost-effectiveness of adaptation actions, and the co-benefits or regrets associated to the actions.
 - Impact and risk modelling for decision-makers and other stakeholders, in particular to support the development of robust decision-making under uncertainty.
- Draw-up a roadmap of R&I priorities on adaptation modelling and associated economic modelling, risk assessment, cost-effectiveness valuation and management tools towards a 2030-2035 timeframe.

To ensure assessments and tools developed by the projects are truly user-friendly, projects should consider participatory approaches to test such assessments and develop comprehensive and non-technical guides to use the results and outputs of the project(s), at regional and local level in representative cases of the climate regions of Europe⁵².

The use of environmental observations and Earth systems models innovations funded by EU R&I programmes (FP7, Horizon 2020) is encouraged. This should include using data from the Copernicus Climate Change Services, and other relevant sources (such as GEOSS).

The project should closely coordinate with and integrate the results of the existing studies and evidence-based research, namely from projects from topic HORIZON-MISS-2021-CLIMA-02-03 “Towards asset level modelling of climate risks and adaptation”⁵³, HORIZON-MISS-2021-CLIMA-02-01 “Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach”⁵⁴, and the Study on Adaptation Modelling for Policy Support⁵⁵.

Proposals should include a mechanism and the resources to establish operational links with the Mission Adaptation to Climate Change Implementation Platform and Climate-ADAPT platform (run by the European Environment Agency (EEA) together with DG CLIMA) so

⁵² As presented in the Working Group II IPCC Report, Chapter 13: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report*

⁵³ [Funding & tenders \(europa.eu\)](https://ec.europa.eu/funding-tenders/opportunities/portal/screen/opportunities/topic-funding)

⁵⁴ <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-miss-2021-clima-02-01>

⁵⁵ <https://op.europa.eu/o/opportal-service/download-handler?identifier=cfa86c26-764e-11eb-9ac9-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=>

project results can be fed into the platform for them to be used by Mission participants, namely regions and communities.

Coordination with the Destination Earth initiative should be explored to ensure the timely development of “climate replicas” utilising the new state-of-the-art IT infrastructure, including access to EU high performance computing resources and an operational platform to upload and integrate the models and data developed in the course of the projects.

The participation of social sciences and humanities is key to address the socio-economic, decision-making and local governance aspects of this topic. Furthermore, projects should consider the involvement of citizens and societal actors, to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Social science, citizen science and behavioural science for climate action

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-08: Solar Radiation Modification: governance of research

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 3.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ⁵⁶
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Expected Outcome: The purpose of the action is to explore conditions that could lead to the development of a possible governance framework for experimental research in the area of solar radiation modification (SRM), which is to be done on a case-by-case basis. SRM is defined as an approach to reduce solar radiative forcing through means other than through the reduction of net greenhouse gas emissions. The action should identify, on the basis of a comprehensive and balanced assessment of the best available scientific knowledge, as well as the perspectives of stakeholders, whether and how the governance of SRM field research could work in practice.

The IPCC 6th Assessment Report (Cross-Working Group Box SRM: Solar Radiation Modification⁵⁷) concluded that SRM could offset some of the effects of anthropogenic warming on global and regional climate, especially if combined with emissions reductions, and with carbon dioxide removal, and phased out gradually. However, a number of risks are associated with its deployment, and the IPCC found that there is low confidence in our understanding of the climate response, especially at regional scales. At international level, its deployment is addressed (and strongly discouraged) by the Convention of Biodiversity due to its potentially substantial negative effects on biodiversity. Nevertheless, the topic continues to draw interest, including from non-state actors, as the effects of climate change itself become more evident.

This action should lead to a better understanding of what the risks and conditions are that would make field research acceptable or unacceptable to stakeholders. Such enhanced understanding is sought without prejudice to its potential use in policy-making or regulation.

Scope: In order to achieve the expected outcome, proposals should address **all of the** following:

- Synthesis of the state of the art regarding the potential contribution of SRM to climate stabilisation, and its associated risks.
- Clarification of what activities constitute SRM, and the extent to which SRM is permitted, prohibited and/or governed within the ERA at present.
- Proposal of principles and guidelines that could be used by a public authority for permitting, prohibiting or supervising SRM field experiments on a case-by-case basis. Factors to consider could include inter alia:

⁵⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

⁵⁷ Page 2473 of Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report. Available: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FullReport.pdf,

- o Scientific and operational preconditions (e.g. monitoring mechanisms during and after research, time horizon, contingency planning).
- o Legal issues (e.g. liability for impacts).
- o Decision-making processes and ethical considerations (e.g. Who gets to decide? Procedural aspects such as how to ensure broad, informed stakeholder consultation).
- o Approaches to cost-benefit analysis and risk assessment in a context of uncertainty (risk of action, and risk of inaction).
- An inclusive expert and stakeholder dialogue process, aligned with the principles of Responsible Research and Innovation (RRI) should be organised in order to inform the analysis mentioned above.

The action is also encouraged to consider the following questions:

- Whether SRM field research under controlled conditions (e.g. within the ERA or like-minded jurisdictions) could lessen the risk of its unregulated deployment elsewhere in the world.
- Comparison of the risks of SRM with analogous risk management dilemmas faced by science and society.

The action should also identify what the characteristics of such a governance framework should be, taking into account issues such as scientific rigour, risk assessment and public legitimacy.

Promotion of SRM or conducting of SRM field experiments are outside of the scope of this action.

Actions are encouraged, where relevant, to explore synergies with other initiatives in Europe and beyond investigating Solar Radiation Modification from a technological, regulatory and/or ethical perspective.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-01-09: Behavioural change and governance for systemic transformations towards climate resilience

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately.

<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Projects are expected to contribute to **all of the** following outcomes:

- Support to the implementation of the EU Adaptation Strategy and the Mission on Adaptation to Climate Change.
- Decision-makers at local, regional, national and European level are able to more effectively scale up and accelerate behavioural change for systemic transformations towards climate resilience, knowing more about relevant social tipping points, leverage points and key governance interventions in this context.
- Citizens and civil society have a better understanding of possible individual actions they may wish to undertake or how to contribute to strategic leverage points that bring about behavioural change supporting climate resilience at larger scale. This should also include knowledge or development of possible governance structures and organisational innovations that would help to galvanise the already existing knowledge and activities in many parts of society.
- Easier assessment of the potential of and progress in scaling up change in behaviour and creating multiple positive synergies of individual and organisational actions for directing governance to achieving systemic transformations towards climate resilience.

Scope: No matter how successful our efforts to mitigate further climate change will be, some impacts are or will be unavoidable in the future and we will have to adapt to a warmer world. The question is on what terms this adaptation will take place. With the new Strategy on Adaptation to Climate Change and the recently launched Mission on Adaptation to Climate Change on this issue, Europe has set out that the direction of this change will be systemic transformations towards climate neutrality and resilience, by 2050.

As nations, regions, cities and local communities are now developing their vision and pathways towards climate neutrality and resilience, increased importance is given to the role of behavioural change, and governance and organisational innovation in achieving the systemic transformations needed to regain resilience in a harsher climate future to events and hazards potentially attributable to climate change.

The objectives of this topic are to reach a better understanding on behavioural change and on how it could be scaled up and connected to the governance of the various drivers of and/or barriers to climate-friendly/climate-resilient behaviour (including EU, national and local policies) to reach the goal of climate neutrality and resilience by 2050.

The role of individual or community behavioural change in this societal transformation is to be approached as embedded in changes of informational, political, economic and technological systems. Shifts from individual values and community behaviour need to be seen as integrated with societal changes in governance, implying a combination of cultural changes and shifting social norms, alongside interventions by institutions and through the market, communications and media⁵⁸.

Within this scope, projects are requested to enhance the understanding of:

- **Social tipping points and leverage points in climate adaptation:** to better understand the social acceptability of non-adaptive behaviours or how new adaptive behaviour would become widespread (social tipping points); to better understand how a small shift in one part of a system would generate changes across the system as a whole (leverage points); to better understand how various systems' leverage points may eventually lead to deliberate transformative tipping points; to understand how increasingly serious threats or consequences of climate change lead to changes of individual and social perceptions and behaviours, and how it leads to changes in local adaptation policies, new social organisation forms and actions. This should also include analysis of incentives and barriers to behavioural change in different spheres of the population (according to gender, social conditions, educational level, etc.).
- **Features of good governance for systemic transformations to climate resilience:** to better understand features and structures of governance and institutions to ensure economically, socially and environmentally just transformations appropriate for the local conditions, e.g. mechanisms leading to most cost-effective solutions; a fair distribution of costs and benefits of the transformations; to better understand features and structures of governance and institutions that generate a high systemic adaptive capacity, e.g. the ability to effectively leverage public-private sector investment for adaptation actions; further operationalisation of the notion of equity and justice to support the required transformative systemic adaptations in governance and policy arrangements.
- **Transformative conditions, capacities and learning feedbacks needed for systemic change:** to better understand the conditions and capacities that would allow individual behaviour to fundamentally change the system in which they operate so that the system further accelerate new learning feedbacks and changes in individual behaviour, e.g. via experimentation and requiring further access to relevant knowledge and information or opportunities to engage in transformative decision-making.

⁵⁸ Changing our ways? Behaviour change and the climate crisis, 2021, Report of the Cambridge Sustainability Commission on Scaling Behaviour Change.

Projects should focus on all relevant aspects of society, in their interactions with biophysical and climate adaptation components, including, but not limited to, relevant economic sectors, education and up-skilling and re-skilling. Moreover, participatory co-creation approaches at policy making, community, and individual levels, including direct involvement of citizens, new sustainability-oriented business organisations and societal actors where relevant considering social innovation, is highly recommended in order to create robust results. Projects should investigate the dimension of lifestyles and habits and associated factors, motivators and barriers, and be aware of the role of gender and diversity among populations and groups of populations, and how various resources and power relations can influence people's decisions and willingness to change behaviour.

Projects are expected to contribute to and establish close coordination with the activities of the Mission on Adaptation to Climate Change. They are strongly encouraged to use the results of the Mission on Adaptation to Climate Change and the Copernicus Climate Change Service as testbed to underpin their findings.

Finally, projects are requested to develop the following outputs:

- Concrete recommendations of operational nature to accelerate systemic change in those regions and communities that served as their case studies.
- General guidance for all other actors at national, regional, or communal level about the most feasible and effective leverage point potentially leading to transformative tipping points, including aspects concerning interrelations, alignment and coordination of the actors/stakeholders.
- A science for policy operational framework and indicators for assessing the potential of and progress in scaling up change in behaviour and for directing governance to achieving systemic transformations towards climate resilience.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-01-10: Improving the evidence base regarding the impact of sustainability and climate change education and related learning outcomes

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.

<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>

Expected Outcome: Project(s) are expected to contribute to **all of the** following expected outcomes:

- A better understanding of which interventions and measures are effective to produce intended but also novel learning outcomes needed for the green transition of our society and economy.
- Improved methods for measuring impact and implementation of sustainability and climate-related education.
- Better feedback-loops between improved output-oriented monitoring of sustainability and climate-related education and education policy-related decision-making, including planning and reorienting curricula and programmes, to ensure that policy and programmes remain relevant and effective.

Scope: The dimension of “sustainability and greening of education and training systems” is still relatively new in the EU context⁵⁹. Through the Commission’s proposal on learning for environmental sustainability⁶⁰ as well as European sustainability competence framework⁶¹ – both published in 2022 – EU Member States/Associated countries have received new impetus to implement education and training related to the environment and sustainability. For effective policy-making, including development and revision of curricula and study programmes, it is necessary to assess and monitor the impact that sustainability-related education has. The objective of this project is therefore to better understand and to provide recommendations on how to measure what learners actually learn and how this influences mind-set and actions on sustainability at the individual and collective level.

Projects should therefore:

- Address both inputs to and outcomes of learning⁶² and the processes that link them: Methods that address impact assessment of learning outcomes require taking into

⁵⁹ EU Green Deal and other key EU initiatives highlight the importance of education and training for the green transition.

⁶⁰ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2022:11:FIN>

⁶¹ <https://publications.jrc.ec.europa.eu/repository/handle/JRC128040>

⁶² Learning outcomes relate to what learners know and can do after a “learning intervention”, usually after an extended period of time (like a study programme). Learning interventions themselves depend on a range of inputs (inducing investments, policies, curricula design). Learning outcomes are usually described as knowledge, skills and attitudes that learners have developed in a specific area.

account commitment (e.g. legislation, policy measures, top-level strategies and action plans), context (governance, structure of education system) implementation (e.g. funding, governance, curricula, teacher training, sustainable infrastructure and resource management) and results (e.g. learning outcomes in terms of skills and competences).

- Capture the lifelong learning scope and ambition of learning for sustainability: to do so, it will be important to widen the current focus of monitoring pupils and students (mainly at secondary level) to both younger and older generations. Moving beyond formal learning and even beyond education to measuring impact in the wider economy and society requires taking into account contextual factors - both education-related and non-educational - that might influence learning outcomes.
- Address novel concepts and competences put forward in sustainability and climate change education, such as participatory and challenge-based education, living labs, exploratory and futures thinking. Such approaches encourage learners to imagine and create what does not yet exist, yet they are difficult to capture with pre-defined targets and indicators. Research should therefore go beyond test-based student assessment, which often serves to monitor and measure impact and progress in the area and include aspects such as links with the local community or interdisciplinary, hands-on and socio-emotional approaches, which are crucial for effective learning for sustainability.

Actions should envisage clustering activities with relevant projects and initiatives, such as the two Horizon 2020 projects ECF4CLIM and GreenSCENT, the GreenComp (the European sustainability competence framework developed by the JRC) for cross-projects cooperation, consultations and joint activities on crosscutting issues, to share their results, as well as to participate in joint meetings and communication events. To this end, proposals should foresee a dedicated work package and/or task and earmark the appropriate resources accordingly.

Projects are requested to develop the following outputs:

- A set of indicators to monitor progress in implementing such education measures.
- A mapping of policy evaluation methods, monitoring frames and indicators and their relation with approaches and programs in the area of sustainability and climate change education, in EU Member States/Associated countries and internationally, with the objective to identify best practices and reproducible solutions. This should build on work developed during the UN Decade in Education for Sustainable Development (DESD) and the Global Action Programme for Sustainable Development (GAP), which include a “Global Monitoring and Evaluation Framework” as well as evaluation and assessment of impacts through large-scale testing (including international assessments, such as PISA, TIMSS, PIRLS), project-based monitoring/assessment, surveys, etc.
- Definition of suitable areas for assessment of the impact of education policies/interventions (e.g. measurement of skills/competence of learners, educators; investment in green education; link between education and engagement in sustainability and climate action; effective communication strategies; training of professionals).

- A comprehensive assessment model on the basis of a wide range of indicators (e.g. capturing commitments, implementation and results).
- A methodology tailored for conducting impact assessments and evaluations of policies on learning for sustainability (taking into account inputs, processes, context, outcomes), addressed to and adaptable to different education and training approaches and levels in a life-long learning context (i.e. early childhood education and care, school, vocational education and training (VET) and higher education, citizen science, non-formal learning).
- Running of minimum 2 case studies using the developed methodology.

This topic also requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

International cooperation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-11: Needs-based adaptation to climate change in Africa

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>The following additional eligibility criteria apply: Consortia must include at least 3 entities established in at least 2 different Sub-Saharan African countries⁶³.</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>

⁶³ Sub-region 202, as defined by the United Nations Statistics Division: <https://unstats.un.org/unsd/methodology/m49/overview/>.

Expected Outcome: Project results are expected to contribute to **all of the** following expected outcomes:

- Accelerated deployment of climate services to build climate resilience.
- Better informed climate adaptation policy response, stronger adaptive capacity and climate resilience in Africa, with a focus on the Sub-Saharan region.
- Improved synergies between adaptation action and other policy objectives, notably the Sustainable Development Goals agenda.
- Contribution to the international dimension of the EU Adaptation Strategy and to the Africa-EU Partnership.
- Knowledge base to underpin major international scientific assessments such as the IPCC Assessment Reports.

Scope: The African continent is on the frontline of the climate emergency; it is highly vulnerable and adaptation to both present and future impacts of climate change is urgent and crucial to secure its long-term resilience and prosperity but it is challenging in the current economic context. While the demand for high-quality, actionable climate information and services is growing, there is a need for more holistic, better connected, more interactive and more user-oriented approaches across the entire adaptation value chain from knowledge production to users. This ranges from improved knowledge base, through increased accessibility, up to enhanced uptake of information and climate services by end-users spanning policy makers, governmental agencies, local authorities, civil society and the private sector. The focus of this topic is on countries in Sub-Saharan Africa – given the region's limited response capacities coupled with high vulnerability to climate change impacts that range from droughts, through rising sea levels, cyclones, and floods to rising temperatures and rainfall anomalies with serious implications, notably, for food and water security.

Actions should:

- Improve the understanding of current and future climate related threats (and opportunities) in Africa in the context of socio-demographic developments, extending into sectors/domains that are underexplored from climate-risk perspective and including dynamics between climate, biodiversity, and political/economic risks such as migration, food security and urbanisation patterns. Actions may address improvements in accuracy and skill of forecasts/projections, in particular as regards the sub-seasonal-to-seasonal time scale.
- Identify key adaptation challenges, needs and gaps in the broader socio-economic context, including intersection with other policy objectives such as biodiversity protection, increase in agricultural productivity and reduction of inequalities.
- Enhance planning, implementation and evaluation of climate adaptation strategies and measures (including ecosystem-based adaptation and nature-based solutions, as well as

integrated adaptation and mitigation actions) and the understanding of their socio-economic determinants and benefits.

- Improve and upscale existing and/or develop and test new climate services/tools that bridge the gap between information availability and uptake by end-users in different sectors, including through capacity building and addressing issues such as access, uncertainty, trust, risk perception and management, and other barriers. In either case, actions should demonstrate a clear path towards broader deployment of the services developed.
- Promote better understanding and enhanced cooperation between various actors such as regional climate centres, national meteorological services, intermediaries, and end-users. Direct participation of relevant entities in the projects is strongly encouraged.
- Explore and leverage opportunities associated with the digital revolution (including progress in automation, artificial intelligence, and communications) to improve diffusion of climate knowledge and promote more efficient service delivery.
- Advance knowledge on value assessment of climate services and apply it to the services developed within projects.

Projects may focus on a specific country/region in Sub-Saharan Africa for more customised activities but should evaluate and disseminate information on the broader relevance of their outcomes and options for replication also in other locations.

Actions should pursue active engagement and consultation with relevant stakeholders such as African government agencies, civil society organisations and citizen groups to harness local knowledge and to better account for end-user needs, taking into account the gender dimension. This should include research on co-production of climate information and user engagement models themselves to define which approaches are most suitable for adaptation purposes. Moreover, social innovation should be considered in order to achieve the expected outcomes.

Actions should build on previous work and established structures in the region. Participants should make use of the latest socio-economic, geophysical, and other relevant data, leveraging by rapid progress in digital technologies. This should include observational data from the Copernicus part of the EU Space Programme and other relevant sources (such as in the context of GEOSS Global Earth Observation System of Systems).

Actions should also take into consideration the results of relevant Horizon 2020 projects, such as FOCUS-Africa, Down2Earth, CONFER or HABITABLE, in view of progressing the state of the art and taking the already developed services/tools to the next level.

In line with the Strategy for EU international cooperation in research and innovation (COM(2021) 252), international cooperation is encouraged and projects should aim at comprehensive involvement of African researchers and organisations, in view of maximising the impact and relevance of the projects.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research. Applicants should ensure that their project and activities do not exacerbate tensions in the region and may consider guidelines to integrate conflict sensitivity in climate action projects.

Call - Climate sciences and responses

HORIZON-CL5-2023-D1-02

Conditions for the Call

Indicative budget(s)⁶⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁶⁵	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023				
HORIZON-CL5-2023-D1-02-01	RIA	5.00	Around 2.50	2
HORIZON-CL5-2023-D1-02-02	RIA	5.00	Around 5.00	1
Overall indicative budget		10.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and</i>	The criteria are described in General Annex

⁶⁴ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

⁶⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>exclusion</i>	C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

International cooperation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-02-01: EU-China international cooperation on data and model development for pathways to carbon neutrality: focusing on decarbonisation, energy efficiency and socio-economic implications of the transition

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>In order to achieve the expected outcomes and to implement the Climate Change and Biodiversity Flagship in compliance with the provisions of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People’s Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support Collaborative Research and Innovation projects under the “Food, Agriculture and Biotechnologies”, and the “Climate Change and</p>

	<p>Biodiversity” Joint Flagship Initiatives”, and in accordance with the requirements of the Inter-governmental Science and Technology Innovation (STI) Cooperation Special Programme of MOST.</p> <ol style="list-style-type: none"> 1. Consortia must also include as associated partners at least three independent legal entities established in China. 2. Legal entities established in China can only participate as associated partners; and 3. Chinese participants must be awarded co-funding by MOST *. <p>*This condition will not be fulfilled if, at the time of grant agreement signature, the Chinese participants have not concluded a grant agreement with MOST.</p>
<p><i>Legal and financial set-up of the Grant Agreements</i></p>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Grants awarded under this topic will be linked to the specific grants awarded by the Ministry of Science and Technology, China (MOST) to the Chinese partners. The respective options of the Model Grant Agreement will be applied.</p>

Expected Outcome: The EU and China have committed to become climate neutral (by 2050) and carbon neutral (by 2060), respectively. Successful proposal(s) will support the transition to a climate neutral and resilient society as part of the EU-China Climate Change and Biodiversity Research Flagship (CCB Flagship).

Actions are expected to contribute to **all of the** following outcomes:

- Improved knowledge and mutual learning in potential pathways towards carbon neutrality and renewable transition to support achieving both regions’ climate targets.
- Overview of promising options and associated benefits and challenges in the short, medium and long-term that are necessary to achieve these climate goals.
- Achieved joint of state-of-the-art modelling and dialogue among relevant experts in the two regions.

Scope: The topic aims at developing a state-of-the-art modelling framework that includes up-to-date representation of technologies and policies in different pathways that lead to climate neutrality from a holistic and sectoral perspective. Successful proposal(s) should include joint work by European and Chinese experts aimed at informing the achievement of each country’s long-term decarbonisation goal. Actions under this call should consider deep reductions and pathways to net zero incorporating mitigation of both CO₂ and other greenhouse gas emissions.

Actions should focus on **all of the** following main areas (the individual bullets are indicative suggestions for focus within each area):

a) Energy efficiency and decarbonisation

- Adapted models to reflect state-of-the-art greenhouse gas emission data.
- Opportunities for decarbonisation of industry and agriculture, for reducing net emissions related to land use, and for mitigation of non-CO₂ greenhouse gases. Evaluate the mitigation potential, co-benefits and side effects, and cost-effectiveness of selected technologies in key industries and their potential contribution to a sustainable, secure and affordable transition.
- Improving energy efficiency, including through electrification in industrial processes, transport and heating systems, as well as for buildings (including through improved design and construction, retrofitting, establishing or improving energy management systems).
- Transformation of energy and transport infrastructure to accommodate zero-carbon technologies and smart demand and to guarantee the reliability of the energy and manufacturing systems.
- CCUS technology to improve the efficacy of CO₂ capture and the understanding of storage potential and security in key regions and in industries.
- Improved knowledge concerning the policies needed to ensure the transformation of the different sectors from fossil fuel-based to net-zero carbon emitters.

b) Socio-economic implications

- Socio-economic challenges and opportunities in the transition to climate neutrality, including the transformation of the labour market and the distributional repercussions for different sectors, social groups and regions.
- Consequences of the green transition for human welfare, including on health.
- Opportunities and challenges related to consumer behaviour and lifestyle changes (e.g. consumer choices, changes in ways of living and working).
- Global implications of EU and China decarbonisation (e.g. through trade and commodity markets, impacts on climate action in third countries).

c) Dissemination and stakeholder engagement

- Strong component of engagement, in terms of co-design and co-creation of the pathways, with public and private sector stakeholders in both regions, in particular with groups whose actions will be key to implementing and achieving the transition.

This topic is part of the EU-China flagship initiative on Climate Change and Biodiversity, which will promote substantial coordinated and balanced cooperation between the EU and China, and is within the scope of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People's Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support collaborative research projects under the Climate Change and Biodiversity (CCB) and the Food, Agriculture and Biotechnologies (FAB) flagship initiatives.

Interactions with other actions developed under the EU-China Climate Change and Biodiversity Research Flagship and/or the Flagship on Food, Agriculture and Biotechnologies are encouraged.

The envisaged knowledge relates only to policy, modelling and pathways definition and planning. Development of specific technologies above TRL 4 are out of the scope of this topic.

Actions should:

- Build on existing modelling work in both regions that has identified credible pathways to net zero emissions, continuing to develop and refine such pathways.
- Ensure that EU and China pathways fit into a consistent global framework (e.g. in terms of global carbon budget and use of scarce commodities).
- Focus on key milestones and enabling conditions needed in the short-term (e.g. by 2030, 2035) and medium-term (e.g. by 2040) to achieve each region's net zero goals. Such milestones and conditions are not limited to emissions levels but can include technological roadmaps for key regions and industries, as well as, regulatory, market penetration and socio-economic developments.
- Consider different geographical scales and the role of cities in the transition pathways.
- Feature a combination of integrated assessment modelling (to demonstrate that pathways are coherent and comprehensive) and other more granular techniques to explore specific transformation options in detail.
- Include stakeholder engagement activities aimed at linking the vision set out in pathways with the actions needed to achieve them (e.g. How mature does a certain technology have to be by when? Is this achievable?).

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁶⁶. In particular, beneficiaries are strongly encouraged to publish results data in open access databases and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding

⁶⁶ FAIR (Findable, Accessible, Interoperable, Reusable).

is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-02-02: EU-China international cooperation on blue carbon

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>In order to achieve the expected outcomes and to implement the Climate Change and Biodiversity Flagship in compliance with the provisions of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People’s Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support Collaborative Research and Innovation projects under the “Food, Agriculture and Biotechnologies”, and the “Climate Change and Biodiversity” Joint Flagship Initiatives”, and in accordance with the requirements of the Inter-governmental Science and Technology Innovation (STI) Cooperation Special Programme of MOST.</p> <ol style="list-style-type: none"> 1. Consortia must also include as associated partners at least three independent legal entities established in China. 2. Legal entities established in China can only participate as associated partners; and

	<p>3. Chinese participants must be awarded co-funding by MOST *.</p> <p>*This condition will not be fulfilled if, at the time of grant agreement signature, the Chinese participants have not concluded a grant agreement with MOST.</p>
<p><i>Legal and financial set-up of the Grant Agreements</i></p>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Grants awarded under this topic will be linked to the specific grants awarded by the Ministry of Science and Technology, China (MOST) to the Chinese partners. The respective options of the Model Grant Agreement will be applied.</p>

Expected Outcome: Blue carbon, understood as coastal marine ecosystems such as seagrass, saltmarshes and mangroves are reported under the chapter of the IPCC inventory guidelines devoted to wetlands. The project aims to investigate this reporting and whether other ecosystems could be included.

Actions are expected to contribute to **all of the** following outcomes:

- An understanding of how the different elements of blue carbon in coastal waters of European countries and the People’s Republic of China contributes to greenhouse gases in the atmosphere.
- Better knowledge of how human activity in managing, destroying or regenerating blue carbon affects its emissions and sequestration of greenhouse gases.
- Measurement techniques for calibration, validation and monitoring blue carbon sequestration and emissions.
- A preliminary estimate of the actual and potential contribution of greenhouse gas emissions and removals by blue carbon ecosystems for the EU and the People’s Republic of China.

Scope: The project(s) should:

- Classify the main parameters that affect emissions and sequestration.
- Develop and test methods for measuring, modelling, and monitoring emissions and removals of greenhouse gases.
- Propose and test a portfolio of methods for managing blue carbon to reduce emissions and increase sequestration.
- Cover representative sample sites on European coasts and those of the People’s Republic of China.

- Assess the current and potential contribution of blue carbon to national greenhouse gas inventories and reporting to UNFCCC and determine how the verification and monitoring could be improved.
- Identify whether and how net carbon removals through algae cultivation and human activity in other coastal ecosystems could be quantified.
- Engage with international bodies and researchers tackling the same issue.

Development of specific technologies above TRL 4 are out of the scope of this topic.

This topic is part of the EU-China flagship initiative on Climate Change and Biodiversity, which will promote substantial coordinated and balanced cooperation between the EU and China, and is within the scope of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People’s Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support collaborative research projects under the Climate Change and Biodiversity (CCB) and the Food, Agriculture and Biotechnologies (FAB) flagship initiatives.

Interactions with other actions developed under the EU-China Climate Change and Biodiversity Research Flagship and/or the Flagship on Food, Agriculture and Biotechnologies are encouraged.

Actions should, during their lifetime and within the framework applicable to the cooperation with Chinese entities, establish synergies with relevant Horizon Europe projects and initiatives, such as under cluster 5 destination 1 topic D1-5: Enhanced quantification and understanding of natural and anthropogenic methane emissions and sinks, as well as under cluster 6, in particular topic HORIZON-CL6-2023-CLIMATE: Ocean and coastal waters carbon- and biodiversity-rich ecosystems and habitats in Europe and the Polar Regions, Copernicus Marine Services and the Mission Restore our Ocean and Waters by 2030.

Call - Climate sciences and responses

HORIZON-CL5-2024-D1-01

Conditions for the Call

Indicative budget(s)⁶⁷

Topics	Type of	Budgets (EUR	Expected EU contribution per	Indicative number
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⁶⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

	Action	million)	project (EUR million) ⁶⁸	of projects expected to be funded
		2024		
Opening: 12 Sep 2023 Deadline(s): 05 Mar 2024				
HORIZON-CL5-2024-D1-01-01	RIA	15.00	Around 15.00	1
HORIZON-CL5-2024-D1-01-02	RIA	22.00	6.00 to 7.50	3
HORIZON-CL5-2024-D1-01-03	RIA	15.00	Around 15.00	1
HORIZON-CL5-2024-D1-01-04	RIA	12.00	Around 6.00	2
HORIZON-CL5-2024-D1-01-05	RIA	14.00	Around 4.50	3
HORIZON-CL5-2024-D1-01-06	RIA	5.00	Around 5.00	1
HORIZON-CL5-2024-D1-01-07	RIA	20.00	Around 10.00	2
Overall indicative budget		103.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant</i>	The rules are described in General Annex G.

⁶⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Agreements</i>	
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Earth system science

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-01: Enhanced quantification and understanding of natural and anthropogenic methane emissions and sinks

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: This activity is expected to foster and enhance collaboration between the modelling and observing (satellite, ground-based, airborne) communities and advance towards an enhanced global and regional assessment of the methane sources and sinks from land and the ocean, their short and long-term evolution as well as the related natural and anthropogenic processes and impacts on atmospheric chemistry and dynamics and on Earth radiation

budgets. The expected outcomes hereafter are complying with the recommendations formulated by the user community during the ESA ATMOS-2021 conference⁶⁹.

Project results are expected to contribute to **all of the** following outcomes:

- A significant European effort to develop an enhanced methane assessment capacity including extensive advanced in situ data at multiscale and from multi-platforms, novel satellite observations, and enhanced modelling efforts to quantify and understand hotspots and background for natural and anthropogenic methane emissions with unprecedented resolution in space and time.
- An increased coordination of in-situ observations of methane emissions including enhancing communication and networking between the relevant observation communities.
- Enhanced science base in Europe to perform global and regional (European) scale high-resolution assessment of the methane sources and sinks in relevant environments, their short and long-term changes, the related natural and anthropogenic sources, and impacts on atmospheric chemistry and dynamics.
- Clear policy advice on current and future climate contributions of methane on global and regional (European) scale, including elaboration on effective mitigation options.
- Provision of a significant contribution to IPCC and related scientific efforts regarding reducing methane emission uncertainties similar to those of the Global Carbon Project⁷⁰.
- Contribution to achieve the goals of the COP26 Glasgow agreement on methane emission reductions and to the EU methane strategy⁷¹.

Scope: The challenge of this topic is to further quantify and understand natural and anthropogenic methane emissions based on carefully selected European land sites and European sea sites with unprecedented resolution in space and time that should leverage the latest advances in observations from satellite, ground-based, and airborne, together with advances in reconciling inverse and bottom-up modelling approaches.

The proposal will address this challenge through:

- Deploying large coordinated in situ, ground-based and airborne observation monitoring campaigns over different Earth's ecosystems (terrestrial, terrestrial-aquatic continuum, and marine sub-seafloor) and key anthropogenic sources (e.g. agriculture, waste, mining, oil and gas industry) with comparable and scalable measurement approaches.
- Running these campaigns during an extended period of time and planning them beyond the duration of the projects, building on existing measurement infrastructures and

⁶⁹ <https://atmos2021.esa.int/>

⁷⁰ <https://www.globalcarbonproject.org/>

⁷¹ https://ec.europa.eu/energy/sites/ener/files/eu_methane_strategy.pdf

initiatives, in order to support the validation of satellite products, but as well to support the development of new and enhancement of existing models and data assimilation techniques.

- Evaluating temporal change in methane release over centuries at selected, relevant sites from existing long-time series.
- Advancing towards an integrated methane observing system (on “facility scale”) that capitalises on the latest advances in observations from satellite, in situ, ground-based remote sensing and airborne instruments as well as results from citizen observations.
- Advancing the capacity of models and data assimilation techniques, related to methane emissions through specifically exploiting novel medium and high-resolution satellite data (e.g. GHGSat, PRISMA, Sentinel-2, Landsat-8/9, Worldview-3).
- Delivering inverse modelling to separate methane sources and sinks and to attribute inverse modelling estimated fluxes to specific processes building on sufficient spatial resolution to identify the origin, for instance, of large local emissions.
- Advancing towards an enhanced spatially and temporary high-resolution global and regional assessment of the methane sources and sinks and its dynamics over time, the related natural and anthropogenic processes, and impacts on climate.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Atmosphere Science Cluster⁷² and relevant ESA activities related to the use of the TROPOMI and other relevant missions.

Proposals should address the collaboration with ongoing or future ESA Atmosphere Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

ESA will contribute to this effort by providing a dedicated Earth observation satellite scientific component to complement, collaborate and coordinate with this activity. In particular, ESA will contribute with dedicated set of complementary scientific activities with special focus on exploring and exploiting the new capabilities offered by TROPOMI in combination with other relevant European and international satellite missions including novel very high-resolution observations.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects

⁷² <https://eo4society.esa.int/communities/scientists/esa-atmosphere-science-cluster/>

such as assumptions, code and data that is managed in compliance with the FAIR principles⁷³. In particular, beneficiaries are strongly encouraged to publish results data in open access repositories and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2024-D1-01-02: Inland ice, including snow cover, glaciers, ice sheets and permafrost, and their interaction with climate change

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 6.00 and 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 22.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Actions are expected to contribute to **all of the** following expected outcomes:

- Advanced knowledge on the impacts of climate change and different natural and socio-economic drivers on inland ice and permafrost, and its global repercussions, including climate-ecosystem interactions, which is relevant to international initiatives, such as the World Climate Research Programme (WCRP)⁷⁴'s Climate and Cryosphere Project, or the IPBES.
- Further developed and improved climate and Earth System Models (ESMs) that inform the international climate assessments (e.g. CMIP models, CORDEX) and support the

⁷³ FAIR (Findable, Accessible, Interoperable, Reusable).

⁷⁴ <https://www.wcrp-climate.org/>

development of “digital twins” under the Destination Earth Initiative and the evolution of Copernicus.

- Advanced provision and use of observations, including in-situ, of complex processes with focus on dynamic and vulnerable regions that may lead to high impact changes.
- Supported climate change adaptation strategies including, where relevant, the development of solutions to enhance the resilience of local communities.

Scope: Snow cover, ice sheets and glaciers affect not only the Earth radiation balance and the global climate, but also continental climate systems, the weather of circumpolar regions and their terrestrial and oceanic carbon dynamics, ecosystems, and sea level. Snow and ice cover regulate the properties of the ground underneath and are interlinked with permafrost in areas where average ambient air temperature is below 0°C.

The research actions should contribute to observing, modelling, and projecting the characteristics, volume, and dynamic of inland ice and permafrost in relevant regions, impacting regional and global climate, taking inter-seasonal, annual, decadal, as well as long-term (centuries) changes into account.

The actions should enhance the understanding of the ice sheet or glacier dynamics and evaluate reversibility or irreversibility of changes on multi-decadal to centennial timescales. Furthermore, actions should quantify other impacts caused by the thawing of the inland ice or permafrost at regional or global levels, like the contribution to sea level rise and stratification or impact on biogeochemistry and ocean currents.

Actions should assess the impact of changing land ice, snow cover, or permafrost on local or regional water cycle and economic supplies and services, evaluate the impact of ice processes on human livelihood and cultures, and identify imminent, medium and long-term potential impacts on ecosystem shifts at local and regional scale.

The actions should provide data, tools, and assessments relevant at regional and local scales to support climate change adaptation and explore, identify and verify ecosystems management techniques to allow better adaptation and maintenance of ecosystem services in a changing land-ice landscape.

International cooperation is strongly encouraged.

Actions should build upon and cooperate with relevant Horizon funded projects (e.g., Arctic PASSION, OceanIce, PolarRES, CRiceS, iCUPE), the EU Polar Cluster, the Copernicus Climate Change Service, the Copernicus Marine Environment Monitoring Service, the Copernicus Land Monitoring Service and the GEO initiative.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the initiative, both institutions aim at coordinating efforts to support complementarities between the Horizon Europe and ESA FutureEO programme.

ESA will contribute to this topic with existing and planned projects focused on improving the observation, understanding and prediction of inland ice, including snow cover, glaciers and ice sheets and permafrost thaw, and their interaction and feedbacks with the Earth and climate system. Relevant ESA activities will be implemented under the Polar Science Cluster⁷⁵.

Proposals should address the collaboration with ongoing or future ESA Polar Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles¹¹. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

Synergies and complementarities should be ensured with the HORIZON-CL6-2024-CLIMATE: Closing the research gaps on Essential Ocean Variables (EOVs) in support of global assessments, HORIZON-CL6-2024-CLIMATE: Ocean models for seasonal to decadal and local to regional climate predictions, and HORIZON-CL6-2024-ZEROPOLLUTION: Tackling human and climate change induced pollution in the Arctic - building resilient socio-ecological systems.

HORIZON-CL5-2024-D1-01-03: Paleoclimate science for a better understanding of the short- to long-term evolution of the Earth system

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

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<https://eo4society.esa.int/communities/scientists/esa-polar-science-cluster/>

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).⁷⁶.</p> <p>Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.</p>

Expected Outcome: The projects funded under this topic will assess climate variability building on past climate and environmental datasets.

Project results are expected to contribute to **all of the** following expected outcomes:

- Better process understanding of past climate changes, their variability and interactions with ecosystems, leading to improved Earth system models based on paleoclimate data.
- Assessment of driving and feedback mechanisms (e.g., the carbon cycle evolution and water cycle process), and precise timing and dynamics of deglaciation and glaciation.
- Future climate change scenarios produced in light of documented past changes in climate and ice sheets, in particular warm climates/high sea-level situations, and abrupt transitions.
- Strengthened Earth system models integrating paleoclimate data, e.g. models of ice sheet, ocean, ecosystem and atmospheric components, enabling understanding of future climate.
- Identification of thresholds in Earth system components, including the biosphere, and feedbacks that may be responsible for non-linear behaviour of the climate system to certain forcings.

⁷⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Development, review, and improvement of indicators of abrupt changes, or early warning signals, and tipping points within paleoclimate records.
- Synthesis of climate variations that will serve as fundamental bases for IPCC future assessment and benchmarks for model inter-comparisons.

Scope: The geological and ice-core records provide long-term information on the conditions and processes that can drive physical, ecological, and social systems during interglacial periods, deglaciations and abrupt climatic events. The challenge of the research under this topic is to test Earth system models over selected past climate scenarios, outside the range of variability recorded over the past centuries.

This challenge will be tackled through the following activities:

- Producing and aggregating in databases high-resolution, well-dated, interoperable paleoclimatic records on climate changes from the past (e.g., temperature, GHG concentrations, sea level, ocean circulation variability, seasonality, and precipitation).
- Using paleo-archives at high resolution to extend the instrumental time series for better understating of the proxy records and for improved quantification of their uncertainties.
- Development of Earth system models with outputs that allow a more direct comparison to paleo-data, modelling climate variability, thresholds, and impacts across timescales from years to millennia (e.g., isotope-enabled general circulation models with dynamic ice sheet components that represent relevant feedbacks).
- Describing short- to long-term climate evolution using quantitative reconstructions from different proxies of past climate periods that are of particular relevance with respect to the current climate change scenario.
- Identification of climate tipping points, cascading effects, and environmental limits using paleo data and model experiments.
- Comparing changes in marine, terrestrial and glacier settings to evaluate ocean–land–cryosphere interactions.
- Documenting and quantifying the natural climate variability, in terms of amplitude, time (onset, duration, frequency) and space (location, extension).
- Allowing for consistent integration of large-scale and more regional/local factors to be reproduced by climate models using natural forcings.

Synergies with projects resulting from the topic HORIZON-CL5-2023-D1-01-02: Climate-related tipping points should be established.

The projects should rely on paleoclimatic data from scientific drilling campaigns, and other appropriate sources.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁷⁷. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

Climate change mitigation, pathways to climate neutrality

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-04: Improved toolbox for evaluating the climate and environmental impacts of trade policies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results are expected to contribute to **all of the** following outcomes:

- Enhance our knowledge and inform policy makers on the positive and negative impacts of trade and trade policy on the climate. Additionally, where relevant, broader effects on the environment, in particular biodiversity, pollution and natural resources depletion may also be considered.
- Improve and enlarge the toolbox of models and other research techniques as well as available data and its processing to analyse the impact of trade and trade policy on the climate.

Scope: Actions are expected to cover **all of the** following areas:

- **Study and quantification of the effects of trade on the climate and the environment**

⁷⁷ FAIR (Findable, Accessible, Interoperable, Reusable).

- o In-depth study/quantification of the technique and composition effects: in addition to the scale effect of increasing production, trade also has an impact on the sector composition of economies and the technologies used for production. The project(s) should quantify and decompose these effects, including their underlying mechanisms/causes.
- o Growth projections of trade related emissions in developing countries and newly developed countries: it can be expected that most of future trade-related emissions will take place in these countries. The project(s) should therefore estimate and quantify these future emissions under different scenarios, including the extent to which this is related to pollution offshoring and pollution haven effects.
- o Estimate the net effect of trade: clarify/quantify how much of trade related emissions would still take place in the context of the domestic economy without international trade. While trade-related emissions are an important part of total world emissions, not enough is known about the counterfactual, i.e. emissions profiles in the absence of international trade.
- o Study the effects stemming from changes in the use of resources attributable to international trade, both in terms of efficiency gains (e.g. in energy and material use) and in terms of changes in the climate impacts associated with production and consumption, and whether externalities are likely to be internalised. For specific sectors, the action should look into emissions linked to the production in different countries versus transport emissions in trade to those countries.
- o Study trade-related climate and environmental impacts in key sectors like agriculture and livestock, including linkages to regional land use change, water resources and differences in agricultural production techniques worldwide. Specific tools and methodologies for agriculture and livestock should also be proposed and refined to be able to give sector-specific advice to policy makers.
- o Study the public perception vs. the reality of trade impacting on the environment and climate: while in the public debate trade is often associated with increased emissions related to the scale effect, technique and composition effects point to positive impacts in certain cases. Case studies should also include concrete examples of cases where public perception of trade effects on emissions and real effects diverge.
- **Study and quantification of the effects of trade policy on the climate and the environment**
 - o In-depth study/quantification of trade creation and trade diversion effects in relation to the climate and the environment: trade liberalisation affects trade flows through the diversion of such flows as well as inducing additional trade. The project(s) should study the net effect of these phenomena on the climate and the environment.

- o Impact of environmental/climate regulation on trade and competitiveness: it can be assumed that in some cases tightened environmental legislation can lead to compliance costs and competitiveness effects. It should be empirically studied to what extent this assumption is correct and to what extent the so-called ‘Brussels Effects’ impacts these cost and competitiveness effects.
 - o What do the expansion of global value chains, offshoring and their fragmentation (and a possible reversal of such trends) mean for the climate and climate-related trade policy: the project(s) should analyse the effectiveness of climate and trade policies in such an international economic context.
 - o Effects of openness to trade on environmental and climate policy: trade and international exchanges lead to the diffusion of technology and ideas. To what extent do these effects influence emissions and global climate/environmental policies?
 - o The role of trade policy as a tool to address the free rider problems in climate policies: since addressing climate change is a global public good, free-rider problems persist. To what extent can trade incentives and the trade policy toolbox help overcoming these?
 - o Analyse the coherence between trade policies, climate policies and other policies such as nutrition-food, resources policies and development policies that affect the impacts on the climate and the environment. Analyse how these policies affect the trade-off between food security and conservation of natural resources (such as forests and water resources).
- **Methodology and toolbox related aspects**
 - o Impact of trade and foreign direct investment (FDI) on the productivity of sectors (do more productive sectors/producers tend to be cleaner?): the project(s) should endogenise (Global Trade Analysis Project (GTAP) sector productivity to trade beyond a Melitz-type of framework, including the separation of energy efficiency effects among the productivity effects. Currently since, technological change is mostly exogenous or only roughly calibrated in Computable General Equilibrium (CGE) models, technique effects on carbon leakage cannot fully be captured.
 - o Impact of trade on land use (overall and composition), in particular on deforestation: the project(s) should study methodologies that can be used to better understand the effects of trade and trade policy on land use. Actions should also create/update a trade induced land use/land use change matrix for GTAP sectors.
 - o Transport-related pollution: the project(s) should create a transport mode matrix for GTAP sectors per countries and their related emissions.
 - o Enlarge/split the GTAP sectors list for emission-intensive sectors: the project(s) should create/improve the GTAP sector matrix for emission-intensive sectors.

Actions are also encouraged to explore and promote synergies between the use of modelling approaches in international trade analysis and in comparable macroeconomic modelling in climate policy, for example, in Integrated Assessment Modelling.

International cooperation with research clusters, which have specific knowledge in areas of this call, is encouraged.

The project should also include dissemination and capacity-building for the findings and tools created among policy makers at the EU and Member States/Associated countries level.

HORIZON-CL5-2024-D1-01-05: Next generation low-emission, climate-resilient pathways and NDCs for a future aligned with the Paris Agreement

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute **to all of the** following expected outcomes:

- Methodologies and approaches to promote improved transparency, consistency, and clarity of Greenhouse Gas (GHG) emission reduction commitments.

- Production of more diversified, granular, and customised state-of-the-art pathways consistent with the objectives of the Paris Agreement at global, national and sectoral levels in a diverse selection of countries, better reflecting different national circumstances and constraints and promoting synergies between climate action and other policy objectives.
- Science-based evaluation of selected existing pathways, policies, and measures to implement NDCs and Long-Term Strategies to achieve the goals of the Paris Agreement.
- Extended use of modelling, climate change scenarios and mitigation pathways based on provision of tailor-made tools, trainings, and services to end-users.
- Enhanced international cooperation on identification and implementation of effective mitigation strategies that are aligned with the objectives of the Paris Agreement.
- Improved knowledge base to inform the UNFCCC processes, including the design and revision of post-2030 NDCs and the Global Stocktake in 2028, as well as major international scientific assessments such as the IPCC and IPBES reports.

Scope: As showcased by various independent assessments, the current Nationally Determined Contributions (NDCs) and climate policies fall short of reaching the long-term goals of the Paris Agreement. Strengthening is necessary to close the ambition and implementation gaps, and to align national climate action with global objectives, while simultaneously achieving the broader Sustainable Development Goals and social welfare.

Moreover, while countries have put forward plans, strategies, and announcements to reach “net-zero” targets, these commitments are hard to compare due to varying definitions, ranging from “zero-carbon” to “net-zero CO₂” and “net-zero greenhouse gases” whereas choosing different gases, different (time)scales and different aggregation methods can lead to very different climate outcomes. To address these concerns, actions should define principles for high-integrity, more coherent climate commitments and review processes.

Projects should contribute to strengthening of national climate policies, NDCs and long-term strategies, by developing next generation low-emission transformation pathways, with increased sectoral detail, and fostering more holistic and more integrative approaches that promote synergies and minimise trade-offs between mitigation, adaptation, biodiversity and other policy objectives. They should support the creation of tools that evaluate the existing NDCs and facilitate monitoring processes.

Projects should address some of the following aspects in their research:

- Development of sectoral climate transition scenarios (energy production, transport, industry, buildings, food/agriculture etc.).
- Increase the understanding of the role of ecosystems, in particular land use, in NDCs and other climate commitments identifying options for enhancing transparency and coherence with global models and pathways.

- Enhance knowledge about the role of non-CO₂ gases in meeting the temperature goals of the Paris Agreement and the implications for the transition pathways of countries and sectors.
- Improve the integration of climate impacts and risks in mitigation pathway analysis, including cost-benefit analysis.
- Advance knowledge on adequacy and fairness of climate commitments and strategies, taking into consideration feasibility of actual deployment. This should include, but not be limited to, the analysis of the role and effectiveness of international financial flows in delivering on climate goals together with identification of most impactful approaches.
- Improve understanding of how corporate and non-state commitments could affect national/regional mitigation pathways, for example through their effect on global supply chains.

Co-creation with various stakeholders in the private and public sectors is expected under this topic to ensure that the outcomes produced remain relevant for their end-users. Actions should contribute to improving accessibility of climate change scenarios and models by non-specialist audiences, for example through development and delivery of dedicated services and tools that facilitate user-friendly access and proper use.

Actions may cover a set of regions or be focussed on a specific one and explore it in greater detail. However, in all cases consortia should benchmark their results with global mitigation pathways.

International cooperation is encouraged, in particular with countries of the African Union⁷⁸ and least developed countries⁷⁹ requiring support for the design and implementation of their NDCs and long-term strategies, as well as with countries making part of the global top ten emitters⁸⁰.

Synergies with projects resulting from the topic D1-9. 2023 - *Science for successful, high-integrity voluntary climate initiatives* should be established as regards the role of non-state voluntary climate initiatives in achieving the objectives of the Paris Agreement, and with projects resulting from the Horizon 2020 topic [LC-CLA-02-2019 -Negative emissions and land-use based mitigation assessment](#)⁸¹ as regards latest methodological developments.

This topic requires the effective contribution of SSH disciplines including ethics and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

⁷⁸ “African Union member states” includes countries whose membership has been temporarily suspended.

⁷⁹ https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf

⁸⁰ as per, for example, <http://www.globalcarbonatlas.org/en/CO2-emissions>

⁸¹ https://cordis.europa.eu/programme/id/H2020_LC-CLA-02-2019

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond model documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles⁸². In particular, beneficiaries are required to publish data and results in open access databases and/or as annexes to publications. Projects should also take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2024-D1-01-06: The role of climate change foresight for primary and secondary raw materials supply

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p>

Expected Outcome: The successful proposal will support the transition to a digital and low carbon society in the context of the European Green Deal with a particular emphasis on climate change and raw material value chains. In particular, it should contribute to **all of the** following expected outcomes:

- Short-, medium-, and long-term scenarios of changes in the type, origin and quantity of raw materials (metals/minerals) required for the twin transition.
- Geo-referenced projections for the changes to the greenhouse gas and energy footprint associated with the supply of these primary and secondary raw materials with a view to facilitating their use in integrated assessment models.

⁸² FAIR (Findable, Accessible, Interoperable, Reusable).

- Models and data contributing to the development of the European Commission's Raw Materials Information System⁸³.
- Inputs to international scientific assessments such as reports by IPCC, the International Resource Panel and IPBES.

Scope: Achieving enhanced digitalisation and a low carbon society will involve a change in the type and quantity of the raw materials required by the economy. This can result in geopolitical shifts in extraction and processing, as well as an increase in the extraction, processing, and recycling of many minerals and metals, including ones that have so far been only marginally important. Materials are likely to be extracted from increasingly lower grade ores and hostile environments, from mining wastes, as well as through recycling. *Ceteris paribus*, this would involve a general increase in the energy required to supply raw materials, as well as associated greenhouse gas emissions and changes in some other environmental impacts (such as related to transport and land take for mineral extraction and waste disposal). It will also involve changes in technologies and substitution to materials with lesser environmental impact, some of which not sufficiently well understood. This can include consideration of substitution and circular use of materials.

This action will improve knowledge concerning the options, and challenges, in the short, medium, and long-term associated with the provision of raw materials required for the twin transition with a focus on interlinkages with climate change.

Sectors, technologies and material value chains to be analysed will be selected on a justified basis. The project will analyse changes to the carbon footprint associated with supply options for a justified selection of primary and secondary raw materials for short, medium and long-term time horizons. Options analysed will relate to raw materials likely to have large changes in supply due to the twin transition, where important geopolitical and technological changes are likely in relation to the twin transition and circularity.

The analyses should build on established life cycle assessment and product environmental footprint requirements, as relevant, and contribute to their further development. Modelling should be detailed to account for geo-political/site-specific changes in supply, technologies, and e.g. energy consumption. Scenarios will build on, as far as available, existing demand scenarios from European Commission modelling activities, and are expected to take into account the relevant EU policies (Fit-for-55 package, carbon neutrality by 2050). Scenarios are expected to account for the foreseen variation and innovation advances in extraction, processing, recovery, recycling and other technologies along the value chains, including changes to the energy mixes involved at specific locations.

The proposal will include the involvement of experts for the different technologies related to the primary and secondary raw material options selected as well as representatives of the integrated assessment modelling community.

⁸³ <https://rmis.jrc.ec.europa.eu/>

This action will develop state-of-the-art knowledge (models and databases) in relation to climate change and the implications of different options associated with the twin transition and the related increases in supply of some raw materials.

The action will build on existing modelling work for the supply and demand of primary and secondary raw materials and expand them to reflect typical transition pathways, to highlight the implications on climate change.

The action will align to established requirements of existing methodological and data frameworks such as for life cycle assessment and product environmental footprint.

While focusing on selected technologies and site-dependent modelling, conclusions should provide insights related to opportunities and challenges for sectors associated with the twin transition.

Proposals should consider the involvement of the European Commission’s Joint Research Centre (JRC) whose contribution could consist of interacting in relation to the EC’s Raw Materials Information System and its underlying sectorial value chain analyses in the contexts of geopolitical foresight, life cycle assessment, and circular economy.

Stakeholders are to be selected on a justified basis to be consulted at key steps to provide informed feedback on the modelling, data and analyses.

Climate-ecosystem interactions

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-07: Quantification of the role of key terrestrial ecosystems in the carbon cycle and related climate effects

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: A comprehensive assessment and quantification of the role of terrestrial biogeochemical dynamics and the role of vegetation in the carbon cycle, compared to the pre-industrialisation situation, building on dedicated in situ data collection, novel satellite data development, and advanced carbon cycle modelling.

Project results are expected to contribute to **all of the** following outcomes:

- Enhanced understanding and characterisation of the terrestrial carbon pools and fluxes, including through taking account of hydrological exchanges, with unprecedented accuracies and spatial scales, building on the advent of a new generation of satellite missions (e.g., ESA's BIOMASS, FLEX, Sentinel missions, NASA's NISAR, GEDI, ICESat-2 etc...), that radically change the way the terrestrial carbon cycle can be observed.
- Improved methods for the monitoring of key ecosystems state in Europe, regarding terrestrial carbon, including e.g. forestry, croplands, peatlands, inland water, extensive grasslands, tundra, tidal marshes, seagrass, and mangroves, and tackling key gaps in observations, e.g. age-structure, species richness, canopy structure (including use of Terrestrial Laser Scanning), observations of wood density, interaction with hydrology and exchange with the atmosphere in particular observations of biological volatile organic compounds, CO₂, CH₄, N₂O, and black carbon/particulates emissions.
- Improved handling of anthropogenic management practices (land use including forestry) in terrestrial carbon modelling, including lateral transfers of carbon (notably in the form of harvested biomass including exports, imports, and use as well of land-water exchange).
- Improved understanding of impacts on the carbon cycle of extreme events (wind throw, drought, pest outbreaks, fire), and of the impacts of anthropogenic disturbance including degradation and behaviour and recovery of forest post-disturbance.
- Improved consistency between top-down methods such as atmospheric inversions and bottom-up approaches based on land-surface models, in-situ and satellite observation, flux measurements, and national and global statistics.
- Assessment of the consistency of observation and advanced models through benchmarking activities at multiple scales including point measurements, and satellite observations at multiple temporal and spatial resolutions.
- Novel monitoring frameworks combining remote and proximate sensing techniques with machine learning and edge computing.

Scope: The main challenge of this topic is to develop an enhanced capacity to better characterise and reduce uncertainties of the carbon cycle related to key terrestrial European ecosystems as a function of anthropogenic emissions, environmental forcing conditions, and management practices. In order for this challenge to be met, actions should be performed at spatial resolutions required to represent the mechanisms by which human interventions

necessary to move towards net-zero carbon balance, can be quantified. Further, the dynamics and response of vegetation to climate change, short- and long-term stress, natural dynamics (e.g. fire), and especially change in frequency, form and severity of extreme events, need to be better understood and quantified.

Proposals should address the above challenges through:

- Coordinated European effort to expand dedicated campaigns to collect in situ-data, including from citizen observations, on land cover, land use and related changes, and on the main processes caused by these, to support the modelling of these changes based on current and historical trends, and to develop empirically based scenarios connecting land use and land cover change to carbon emissions, and sequestration potential.
- Advances in land surface and carbon modelling supported by high-performance computing capacity, allowing models to be run at unprecedented resolutions, and accuracy, through improved data assimilation workflow from remotely sensed data and vegetation models. The emphasis should be on area wide effect of the ecosystem's microbiome, and consistency across spatial and temporal resolution and with satellite observation processes.
- Extending and complementing satellite observations with elements linked to the LUCAS survey of Eurostat, to the EU Soil Observatory (EUSO) initiatives on integrated soil monitoring systems, and to research infrastructure e.g. eLTER and ICOS, as well as through comparison with past data and through coordination with Earth observation efforts (spectral signature characterisation, biophysical and biogeochemical observations commensurate with satellite resolutions, aircraft / unmanned aerial vehicle campaigns).
- Specific efforts to develop carbon and land surface models consistent with specific variables or outputs that can be directly interfaced or compared with satellite observations e.g. above ground biomass, soil moisture, solar induced fluorescence, disturbance dynamics e.g. fire, and inclusion of additional key processes (coupling with Nitrogen and Phosphorus cycles and water, CO₂ fertilisation, assimilation of photosynthesis rates from global observation for direct gross primary production estimation).
- A significant coordination effort and collaboration with the relevant activities of major international scientific groups (e.g., IPCC, Global Carbon Project), the Copernicus Atmosphere Monitoring Service and the ESA Carbon Science Cluster⁸⁴.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Carbon Science Cluster.

⁸⁴

<https://eo4society.esa.int/communities/scientists/esa-carbon-science-cluster/>

Proposals should address the collaboration with ongoing or future ESA projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

Applicants should ensure coordination with complementary projects funded under the ESA Carbon Science Cluster of the FutureEO programme including relevant ESA activities related to the use of the novel BIOMASS⁸⁵ and FLEX⁸⁶ missions and potentially the Copernicus CO₂M⁸⁷ mission in the future.

⁸⁵ <https://earth.esa.int/eogateway/missions/biomass>

⁸⁶ <https://earth.esa.int/eogateway/missions/flex>

⁸⁷ https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_Sentinel_Expansion_missions<https://www.eumetsat.int/copernicus-co2m-science-support>

Destination – Cross-sectoral solutions for the climate transition

This Destination covers thematic areas which are cross-cutting by nature and can provide key solutions for climate, energy and mobility applications. In line with the scope of cluster 5 such areas are batteries, hydrogen⁸⁸, communities and cities⁸⁹, early-stage breakthrough technologies as well as citizen engagement⁹⁰. Although these areas are very distinct in terms of challenges, stakeholder communities and expected impacts, they have their cross-cutting nature as a unifying feature and are therefore grouped, if not addressed in other places of this work programme, under this Destination.

This Destination contributes to the following Strategic Plan's **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy⁹¹ by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*
- *D: Creating a more resilient, inclusive and democratic European society, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people
- Affordable and clean energy
- Smart and sustainable transport

The **expected impact**, in line with the Strategic Plan, is to contribute to the “*Clean and sustainable transition of the energy and transport sectors towards climate neutrality facilitated by innovative cross-cutting solutions*”, notably through:

- Nurturing a world-class European research and innovation eco-system on **batteries** along the value chain based on sustainable pathways. It includes improvement of technological performance to increase application user attractiveness (in particular in

⁸⁸ The bulk of activities are supported by the Institutional Partnership ‘Clean Hydrogen’.

⁸⁹ Communities and cities are mainly supported under the Mission on Climate-Neutral and Smart Cities, and through the co-funded Partnership ‘Driving Urban Transition’, implemented in this work programme as a grant to identified beneficiary.

⁹⁰ Citizens engagement as well as social sciences and humanities are mainstreamed across multiple topics across various Destinations in this work programme.

⁹¹ ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

terms of safety, cost, user convenience, fast charging and environmental footprint), in parallel supporting the creation of a competitive, circular, and sustainable European battery manufacturing value chain (more detailed information below).

- Nurturing the development of **emerging technologies** with high potential to enable zero-greenhouse gas and negative emissions in energy and transport (more detailed information below).

A competitive and sustainable European battery value chain

Batteries will enable the rollout of zero-emission mobility and renewable energy storage, contributing to the European Green Deal and supporting the UN SDGs by creating a vibrant, responsible and sustainable market. Besides climate neutrality, batteries also contribute to other UN SDGs directly and indirectly such as enabling of decentralized and off-grid energy solutions.

The strategic pathway is, on the one hand, for Europe to rapidly regain technological competitiveness in order to capture a significant market share of the new and fast-growing rechargeable battery market, and, on the other hand, to invest in longer term research on future battery technologies to establish Europe's long term technological leadership and industrial competitiveness

The Partnership “Towards a competitive European industrial battery value chain for stationary applications and e-mobility”, with as short name Batt4EU, to which all battery-related topics under this Destination will contribute, aims to establish world-leading sustainable and circular European battery value chain to drive transformation towards a carbon-neutral society.

The main impacts to be generated by topics targeting the battery value chain under this Destination are:

- Increased global competitiveness of the European battery ecosystem through generated knowledge and leading-edge technologies in battery materials, cell design, manufacturing and recycling.
- Significant contribution to the policy needs of the European Green Deal through new solutions for circularity and recycling of batteries.
- Accelerated growth of innovative, competitive and sustainable battery manufacturing industry in Europe.
- Development of sustainable and safe technologies and systems for decarbonisation of transport and stationary applications.
- Contributing to the strategic independence of Europe through investigation of alternative battery chemistries using non-critical raw materials and efficient recycling technologies.
- Increasing synergies with other partnerships and initiatives.

Emerging breakthrough technologies and climate solutions

Although the contribution of a wide range of technologies to reach climate neutrality is already foreseeable, EU R&I programming should also leave room for emerging and breakthrough technologies with a high potential to achieve climate neutrality. These technologies can play a significant role in reaching the EU's goal to become climate neutral by 2050.

Relevant topics supported under this Destination complement the activities supported under Pillars I or III. They address emerging technologies that can enable the climate transition with a technology-neutral bottom-up approach. Research in this area is mostly technological in nature but should also, where relevant, be accompanied by assessments of environmental, social and economic impacts, by identification of regulatory needs, and by activities supporting the creation of value chains to build up new ecosystems of stakeholders working on breakthrough technologies.

The main expected impacts to be generated by the topic targeting breakthrough technologies and climate solutions under this Destination are:

- Emergence of unanticipated technologies enabling emerging zero-greenhouse gas and negative emissions in energy and transport;
- Development of high-risk/high return technologies to enable a transition to a net greenhouse gas neutral European economy.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D2-01	111.70	16.30	18 Apr 2023
HORIZON-CL5-2023-D2-02	42.00		05 Sep 2023
HORIZON-CL5-2024-D2-01		72.00	18 Apr 2024
HORIZON-CL5-2024-D2-02		39.00	05 Sep 2024
Overall indicative budget	153.70	127.30	

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2023-D2-01

Conditions for the Call

Indicative budget(s)⁹²

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million) ⁹³	Indicative number of projects expected to be funded
		2023	2024		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023					
HORIZON-CL5-2023-D2-01-01	RIA	21.00 ⁹⁴		Around 7.00	3
HORIZON-CL5-2023-D2-01-02	RIA	15.00 ⁹⁵		Around 5.00	3
HORIZON-CL5-2023-D2-01-03	RIA	14.00 ⁹⁶		Around 7.00	2
HORIZON-CL5-2023-D2-01-04	IA	15.00 ⁹⁷		Around 7.50	2
HORIZON-CL5-2023-D2-01-05	IA	12.00 ⁹⁸		Around 6.00	2
HORIZON-CL5-2023-D2-01-06	IA	10.00		Around 10.00	1

⁹² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

⁹³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

⁹⁴ Of which EUR 11.02 million from the 'NGEU' Fund Source.

⁹⁵ Of which EUR 7.50 million from the 'NGEU' Fund Source.

⁹⁶ Of which EUR 7.00 million from the 'NGEU' Fund Source.

⁹⁷ Of which EUR 7.50 million from the 'NGEU' Fund Source.

⁹⁸ Of which EUR 6.00 million from the 'NGEU' Fund Source.

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		99			
HORIZON-CL5-2023-D2-01-07	CSA	4.00 100101		Around 1.00	4
HORIZON-CL5-2023-D2-01-08	COFUND	20.70	16.30	Around 37.00	1
Overall indicative budget		111.70	16.30		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-01-01: Technologies for sustainable, cost-efficient and low carbon footprint downstream processing & production of battery-grade materials (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately.

⁹⁹ Of which EUR 5.00 million from the 'Digital, Industry and Space' budget.

¹⁰⁰ Of which EUR 2.00 million from the 'Digital, Industry and Space' budget.

¹⁰¹ Of which EUR 1.00 million from the 'NGEU' Fund Source.

<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 21.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependency on third countries for critical raw materials by promoting resource efficiency.
- Increased European competitiveness by offering sustainable, safe, energy efficient and low carbon, water and biodiversity footprint battery materials production technologies and scalable solutions and by creating new business opportunities and circular models for European industry.
- Battery-grade intermediates which are developed, produced and refined/purified in a sustainable and socially acceptable way, improving the competitiveness and value of European battery and mobility industries.
- Proven technical feasibility of downstream processing for battery-grade materials at larger scale, considering economic feasibility, safety, health and regulatory targets.
- A stronger European battery manufacturing industry, through the implementation of continuous processes related conditions at larger scale with reduced carbon emissions, increased energy efficiency and more efficient resources use; (e.g. combining secondary materials into existing primary processing).
- Use of European post-mining (or post-extraction, in the case of e.g. geothermal fluids) primary materials and secondary material sources such as tailings (e.g., as a source of nickel, cobalt and lithium) or underutilised battery raw materials deposits and extend the local refining capacity of battery-grade materials, to reduce the dependency on imported materials and to limit supply risks.

Scope: Proposals are expected to cover research and innovation activities with focus on improved battery metal and material production, refining and recovery while minimizing environmental impact of downstream processing by addressing all of the following points:

- Developing sustainable and cost-efficient processing methods for battery-grade materials and components, coming from either primary or secondary streams and novel technologies for battery metals processing enabling the reduction of carbon footprint and other emissions while increasing energy and resource efficiency; enabling thereby vertical integration into the battery production.
- Developing and demonstrating technologies to improve battery grade metals and materials production, refining and/or recycling with efficient and stable reagent circulation, targeting low use chemical and reducing environmental impacts from such processes while improving recovery rate/grade and yield considering the SRIA objectives and KPIs, the Green Deal objectives and the proposed Batteries Regulation¹⁰² where relevant.
- Addressing zero waste and zero discharge strategies for the valorisation of the generated waste materials during the refining processes by: improving the reuse of waste where CRM are present; Increasing the sustainability of batteries materials by reducing the use of chemicals and energy use in the downstream processing considering the objectives of the proposed Batteries Regulation as evaluated by LCA or similar approaches; using safe and low impact disposal methodologies for those materials that cannot be recycled.
- Pre-assessing recycling concepts by their life cycle sustainability and safety impacts (in line with Safe and Sustainable by Design Framework¹⁰³ to be set by the Commission for assessing safety and sustainability of chemicals and materials and which should be considered as a reference in the proposal) and studying overall techno-economical solutions for recovery systems in order to minimize cost, environmental impact and system losses.
- Addressing understanding of physico-chemical mechanisms for more sustainable hydrometallurgical steps in order to propose significant processes' improvements to reduce significantly water effluents quantities and chemical reagents.
- Implementing of continuous process for cathode active materials and precursors synthesis related conditions at larger scale.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the

¹⁰² COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

¹⁰³ See documents defining the SSbD framework and criteria on: https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹⁰⁴ they will contribute.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

International cooperation with Africa, the Mediterranean Region, and the United States is encouraged.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-02: New processes for upcoming recycling feeds (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

¹⁰⁴ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular economy.
- The development of recycling technologies targeting upcoming recycling feeds and producing high quality precursors, semi-products and battery materials enabling their use in the battery production and other production processes.
- Achievement of the recycling efficiency and material recovery targets as described in the proposed Batteries Regulation¹⁰⁵ by industries, especially for low metal and low material value components.
- Recycling chains with a cost-effective process in comparison with primary materials.
- Safeguarding of the sustainability, low CO2 footprint, low chemicals usage and minimal emissions of newly developed recycling processes.

Scope: Proposals should focus on improved and verified circularity of collected, dismantled and pre-treated battery waste feeds (Strong interaction with call “Advanced sustainable and safe pre-processing technologies for End-of-Life batteries recycling (2024)” is encouraged). All recycling concepts should address waste stream(s) in question in a comprehensive manner, aiming at the maximal recovery of input elements and components, rather than selected fractions. Focus on all concepts should be kept on recycling process development considering specific areas of improvement for each of the possible processes of battery recycling; a maximised material recovery and recycling efficiency, operational energy efficiency, less waste water, mass- and energy balance, purity of the recycled material and verified holistically decreased carbon footprint supported by life cycle assessment. Battery development is out of the scope, interaction with other projects is, however, encouraged.

The following issues should be addressed:

- New recycling concepts targeting the recycling of economically low value materials, (e.g. from Lithium-iron phosphate or sodium-ion ...) are expected to be covered. To enable recycling of low value battery compositions, new recycling concepts should be developed, including direct recycling routes that may include selective material recovery technologies and the reconditioning of the active materials. The additional recovery and recycling of non-cathode component materials are encouraged.
- Highly efficient recycling of battery manufacturing scrap, whether emanating from lab-scale or large production, are expected to be covered, for example including direct recycling concepts to re-introduce the materials in the battery production chain, including the handling and processing of relevant semi-material.

In addition, at least one of the following issues are expected to be addressed:

¹⁰⁵ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Highly robust or flexible processes for the recycling of material streams of varying composition and quality may be covered.
- Material feeds from other industries (e.g. Ni/Co rich materials) may be introduced into the recycling concepts.
- Material feeds from future battery technologies with an expected market introduction no later than 2025 may be included.
- The processing of side streams (e.g. waste waters and other waste products) may be targeted.

All proposed recycling concepts are expected to be pre-assessed for their economical, ecological and safety impact.

This topic is building upon the BATTERY 2030+ Roadmap (<https://battery2030.eu/research/roadmap/>). Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08. The proposal is expected to cover the contribution and collaboration to the Coordination and Support Action.

Proposals are encouraged to establish links with those submitted under topic HORIZON-CL5-2024-D2-01-01, “Advanced sustainable and safe pre-processing technologies for End-of-life (EOL) battery recycling”.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹⁰⁶ they will contribute.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-03: Advanced digital twins for battery cell production lines (Batt4EU Partnership)

Specific conditions

¹⁰⁶ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- The understanding of digital twins as systems with automated data acquisition, connected digital models and value-adding applications.
- The capacity to go beyond single process consideration with potential perspective on the process chain.
- The implementation and the transfer of digital twins into existing and future battery cell production plants.
- Safety and security, scalability, explainability, computational speed as well as contributions to sustainability of battery cell production.
- Optimise product quality, improving the resource efficiency and, consequently, the production time and cost of battery cells in the manufacturing process at the targeted scale.

Scope: The battery production chain consists of diverse multi-disciplinary, rather novel processes with numerous influencing factors and interdependencies. Digital twins, as a core element of the accelerating digitisation in manufacturing, bear the potential to improve planning and operation of current and future battery production system. With their connection of advanced digital models and most up-to-date data, decision support or even autonomous control of battery production processes and process chains is enabled. First applications can be found in research and partly also in industrial practice – however, those still tend to be rather specific, covering just selected aspects of digital twins (e.g. just specific models) and are often hardly transferable between production stages and between different battery

configurations in terms of the underlying IT architectures and models. Proposals are expected to address all following points:

1. Developing digital twins of battery cell manufacturing routes at pilot line level that incorporate appropriate models but also their connection to real manufacturing plants, e.g. to support process development and operation, battery cells optimisation, accelerate the set-up of effective manufacturing processes for the next generation battery cells or to demonstrate the capability for predictive maintenance.
2. Design robust digital tools integrating multi-physics, data-driven models and hybrid modelling.
3. Flexible Digital Twins capable to evolve to different battery chemistries, new disruptive materials as well as new manufacturing processes (the model would be chemistry neutral so easily adaptable to new disruptive materials and chemistries).
4. Verify the transferability from pilot to production plant level.
5. Propose applications that will enable to overcome single process considerations towards process chain perspectives.
6. Implementation of the sensorisation of the manufacturing plant and automatisisation of the data acquisition.
7. Ensuring greater interoperability, by implementing available data standards¹⁰⁷, e. g., Modelling-Data (MODA) and Characterisation Data (CHADA), as well as, a common semantic framework, like The European Materials Modelling Ontology (EMMO) and the battery interface ontology (BattINFO).
8. Promote the control and decision making of the manufacturing chain.
9. Aspects like safety and security, explainability of models as well as contributions to sustainability of battery production will be addressed.

This call topic addresses the need of increasing the level of autonomy to the whole battery cell value chain (with special emphasis in the manufacturing). Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

This topic is building upon the BATTERY 2030+ Roadmap¹⁰⁸ and will build upon the shared data infrastructure, standards and protocols developed within this initiative, and in particular the BIG-MAP¹⁰⁹ project. Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-

¹⁰⁷ See <https://emmc.eu>

¹⁰⁸ <https://battery2030.eu/research/roadmap/>

¹⁰⁹ <https://www.big-map.eu/>

01-08. The proposal will cover the contribution and collaboration to the Coordination and Support Action.”

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-04: Battery management system (BMS) and battery system design for stationary energy storage systems (ESS) to improve interoperability and facilitate the integration of second life batteries (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the</p>

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹¹⁰ .
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Battery pack and Battery Management System (BMS) design for single module operation or recombination (reconfiguration) of modules or battery packs for consolidated and new battery technologies.
- Safe, accessible and reliable operation of batteries and compatible with the battery passport concept.
- Battery system design to enable disassembly and reconfiguration for second life.
- Development of fast and efficient qualification strategies and assessment of Electric Vehicle (EV) batteries for second life applications and quantify it with respect to state of the art in terms of time and efficiency.
- Reduction of 30% of repurposing/refurbishment cost for adapting EV batteries to stationary applications in second life.
- Environmental impact assessment, from both positive and negative aspects, for adapting EV batteries to second life applications.
- Impact in the European economy by a growth of the market and employment, by facilitating the uptake of stationary ESS Feasibility of operation in the batteries extended life domain (second life).

Scope: This topic aims at developing an open and interoperable BMS and suitable battery system design for stationary ESS, enabling a better integration of second life applications for used batteries. To strengthen European battery production ecosystem, projects are encouraged to implement batteries produced in Europe, especially with respect to 1st life batteries, at large or pilot plant scale.

In order to fulfil these objectives, activity in all of the following fields is expected:

- The BMS could be used for first and second life batteries in stationary applications, e.g., microgrids, uninterrupted power supply, hybrid (different types of chemistries and batteries, multi-battery management systems) and circular power system, ensuring safety during operation.
- The BMS and system design should be technology agnostic and not exclusive to second life EV batteries and should ideally cover consolidated technologies as well as new

¹¹⁰ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

battery technologies. Pending amendments to Renewable energy directive to be taken into account regarding BMS development.

- Development and validation of open-source algorithms and BMS, allowing for the integration of second life batteries including approaches as semi-empirical, data-driven, and multi-physics supported battery state estimators. Recommendations for the development of standards related to the battery state defining parameters, e.g., State of Health and safety assessment at the end of first life applications.
- Development of BMS software that can be adapted via firmware update to other communication protocols, estimation algorithms and models.
- Development of functionalities focused on increasing the reliability during the second life application, e.g., prediction of remaining useful life, self-diagnostic algorithm for assessment of second life use suitability and BMS connectivity to track batteries during second life application.
- Recommendation to standardisation of a BMS public structure and access to public SOX in order to ease the second use of a battery. The goal is expected to lead to an agreement of a minimum set of data requirements, duly justified, to be provided by the batteries and let the industry define the best procedure to provide this set of data and link up with battery passport concept.
- Development and demonstration of strategies to recombine optimally and safely used batteries to be operated in second life, with special focus on advanced critical event control and mitigation systems. Recommendations for standardisation of second life battery system design for stationary applications based on packs, type of chemistry and cell.
- Design of accessible and adaptable BMS in order to customize the BMS to the requirements of the second life use case, including improved battery models for improved BMS design.
- Demonstration of battery operation in second life use according to TRL6.
- Projects are expected to share information with projects emanating from topic HORIZON-CL5-2023-D2-02-03 where relevant and conform to all relevant EU standardisation requirements.
- The proposal should take into account pending amendments to the Renewable Energy Directive, including Article 20A dealing with access to battery SOX information.
- Proposals are expected to establish links with the results of the following topics - HORIZON-CL5-2022-D2-01-09: Physics and data-based battery management for optimised battery utilisation (Batteries Partnership), HORIZON-CL5-2022-D2-01-10: Streamlined collection and reversed logistics, fully automated, safe and cost-efficient sorting, dismantling and second use before recycling (Batteries Partnership) and

HORIZON-CL5-2022-D2-01-05: Next generation technologies for High-performance and safe-by-design battery systems for transport and mobile applications (Batteries Partnership), [LC-SC3-ES-6-2019 - Research on advanced tools and technological development](#). They should specifically address BMS and system design issues that affect stationary Energy Storage Systems (ESS) and in particular, the integration of used batteries as a second life application.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of performing experimental or desk-top research on battery performance or safety.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-01-05: Hybrid electric energy storage solutions for grid support and charging infrastructure (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all the following outcomes:

- Demonstration of hybrid energy storage technologies for long duration storage (from at least 12 hours to days) and provision of multiple grid services with improved technical performances (increased power and energy density with respect to single electrical energy storage system +20%, reduced storage system losses -10%, improved HESS cycle life +15%, improved reliability and availability +15%), sustainability, as well as increased safety during operation, transport and storage.
- Enable improved levelized cost of storage supported by design optimisation and optimal service stacking, putting the cost of storage on the path to fall below 0.05 €/kWh/cycle by 2030 (for storage durations > 12 hours) while reducing the use of critical raw materials (CRMs).
- Creating synergies between producers and strengthening the European Battery Ecosystem, improving the European battery value chain and thus contributing to the EU climate neutrality objectives.
- Increasing digitalisation of energy storage systems from design to operation phase enabling a faster development and optimal use in grid applications.
- The establishment of multi-service approaches to energy storage reducing costs and increasing benefits for the European electricity system.
- Promoting an increased reliability and resilience of the electricity system by demonstrating new multi-purpose energy storage solutions.

Scope: The objective is to design and demonstrate in at least three different use cases a Hybrid Energy Storage System (HESS) capable of long duration storage and provision of multiple services for supporting the electrical grid and EV charging infrastructure.

In particular, proposals are expected to:

- Design and demonstrate a sustainable and safe HESS either combining different battery technologies, including next-gen technologies, or combining batteries and other electrostatic/electrochemical storage technologies (e.g., supercapacitors) aiming at providing long duration storage while ensuring the possibility of service-stacking and enabling ultra-fast services. Use of second life battery modules is within the scope. The proposed storage solution should be scalable and modular and show clear innovation with respect to the state of the art (new materials or new designs), always bearing in mind the objectives of sustainability and performance. Proper power conversion devices should be selected or customized for enabling an efficient operation of the hybrid storage in grid-connected, grid-following and grid-forming modes.
- Perform a life cycle assessment of the HESS starting from the design phases to ensure its sustainability along the entire value chain, also avoiding, whenever possible, or limiting the use of CRMs.

- Develop physics-based and data-driven digital models of HESS supporting optimal design, and real-time management and diagnosis as well as facilitating the inclusion of storage in grid-planning processes considering forecasted weather conditions, production and consumption. Models should allow the combination of different battery technologies based on specific use cases.
- Develop and validate management policies and control systems (battery management systems and energy management systems) for HESS that maximise the benefits of a hybrid storage, facilitate asset management and participation in electricity and service markets. Pending amendments to the Renewable Energy Directive to be taken into account in development of the BMS.
- Demonstrate HESS usage in at least three different use cases in collaboration with relevant stakeholders (e.g., DSO, EV charging infrastructure owners) and its integration in standard grid architectures (Smart Grids Architecture Model – SGAM) ensuring interoperability for most use cases of energy storage systems (e.g., provision of services to the European grid, supporting islanded and weak distribution grids, load levelling for charging stations).
- Analyse business cases of the proposed hybrid solution considering electricity and balancing markets of three representative EU Member States/Associated Countries, also assessing the applications where HESS provides improved techno-economic performances compared to non-hybridized storage systems.

Proposals are expected to establish links with projects funded under the following topic: HORIZON-CL5-2022-D3-01-10 - Interoperable solutions for flexibility services using distributed energy storage.

The selected projects are expected to contribute to the BRIDGE initiative¹¹¹, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

International cooperation with USA, Australia, Africa or India is encouraged.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

¹¹¹ <https://www.h2020-bridge.eu/>

Cross-cutting

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-01-06: Open Pilot Line/Test Bed for hydrogen

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Contribute to the goals of the European Hydrogen strategy to support the European Green Deal and progress towards climate neutrality by 2030.
- Provide services for testing innovative hydrogen production technology leading to technology upscaling, reducing cost, accelerating time to the market, and reducing investment risk.
- Contribute to the creation of an industrial ecosystem of green hydrogen production technology providers.

Scope: The Staff Working Document on hydrogen highlighting the EU R&I support for implementing the Green Deal hydrogen strategy and contributing to a roadmap of actions called for better synergies at European and national level as well as between European and Member States programmes and activities. A single-entry approach for testing hydrogen production technology was identified as the Open Innovation Test Bed (OITB).

Open Innovation Test Beds were first conceived in the Horizon 2020 work programme. They are entities, established in at least three Member States or Associated Countries, offering access to physical facilities, capabilities and services required for the development, testing and upscaling of technology in industrial environments. OITBs will upgrade existing or

support the setting of new public and private test beds, pilot lines, and demonstrators to develop, test and upscale technologies and services for new innovative products for specific technology domains.

The applicants are required to implement the set-up of an Open Innovation Test Bed (OITB) for hydrogen production technologies. The proposal should address the following:

- Provide services for testing of emerging hydrogen production technologies mentioned in the Agenda Process SRIA¹¹². It will cover all activities from the prototyping to industrial production, and especially the testing in an industrial environment, the validation of the characteristics H2 production technologies and the control of the respect of legal and regulatory constraints.
- Provide a technology assessment base line for future developments of the technology being tested.
- Provide an assessment of the circularity of the technology being tested as well as potential domains for increasing its sustainability /Ensure that the innovations tested contribute to sustainability considering circularity in the design phase, less (or no) use of (critical) raw materials and decreasing negative environmental and social impacts.
- The OITB needs to be operational within the first six month of the start of the project.

Access to the OITB opened to all potential customers. Open access in this context means that any interested party, from Europe and globally, can access test beds' facilities and services independently whether they are part of the consortium or not. It is critical that any interested party from the EU or Associated Countries can access the test beds at fair conditions and pricing and with transparent and mutual obligations with regards to, for instance, security, safety and intellectual property rights.

It is expected that SMEs will have access the test beds at the same conditions as any other entity from the EU or Associated Countries. For SMEs as core targeted user group, the test beds will offer a range of services which are of specific interest to them, e.g. regulatory support and the development of innovative materials that SMEs frequently cannot afford on their own. Proposals should demonstrate a solid and measurable outreach strategy towards SMEs and innovators outside the consortium.

As OITB aims at providing a full service along all the steps of the technological development of a physical innovation, all needed expertise has to be provided to users through a Single-Entry Point (SEP). The SEP is a separate legal entity of which the legal structure is up to the partners involved; however, the consortium needs to come up with a convincing structure that shows its capacity to work together as well as ensure sustainability during the implementation of the grant. If necessary, each test bed will acquire complementary services from other

¹¹² <https://www.clean-hydrogen.europa.eu/system/files/2022-02/Clean%20Hydrogen%20JU%20SRIA%20-%20approved%20by%20GB%20-%20clean%20for%20publication%20%28ID%2013246486%29.pdf>

entities, for instance on characterisation and or modelling, in order to offer a full-service package to users.

The proposal needs to present a credible business plan aiming at future sustainability and operation of the OITB, included after the grant ends. It should set a framework for the definition of the access conditions to their facilities and services respecting transparency and fair access conditions.

Projects should collaborate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory. Where applicable, proposals are expected to complete and/or extend the range of Open Innovation Test Beds that are existing or under development, including those funded under topic HORIZON-CL4-2022-RESILIENCE-01-20.

HORIZON-CL5-2023-D2-01-07: Support for the deployment of R&I results for climate mitigation. Synergies with the ETS Innovation Fund

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 4.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹¹³ .
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Expected Outcome: Project outputs and results are expected to contribute to **all** of the following outcomes:

- Further developing the innovation pipeline from system demonstration to deployment stage for innovation in the EU and Associated Countries.
- Developing scientifically sound mature proposals for the deployment of technological solutions to reduce Greenhouse Gas emissions.
- Establishing synergies between different EU R&I funding programmes.
- Contribute to the REPowerEU plan, as well as the overall EU climate targets.

Scope: The aim of this topic is to promote and facilitate technologically, financially, and operationally mature projects from Horizon 2020 to reach deployment phase by means of developing synergies with other EU funding programmes, namely the ETS Innovation Fund.

The topic aims to support four separate coordination and support actions (CSA), each respectively focussing on **one** of the following areas:

- Low-carbon technologies in energy-intensive industries,
- Carbon capture, use and storage (CCUS)¹¹⁴.
- Renewable energy generation.
- Energy storage & hydrogen.

For each individual CSA, consortia should include partners from at least 3 different Horizon 2020 projects having developed mature technological innovations¹¹⁵ with high potential of deployment under IF^{116,117}. However, depending on the specific sector the consortium focuses on, and on the number of Horizon 2020 projects that have already reached an adequate stage of maturity, a higher number of Horizon 2020 projects represented per individual consortium is preferred.

¹¹³ This [decision](#) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

¹¹⁴ Proposals may include CCU, CCS or CCUS approaches.

¹¹⁵ In particular projects aiming at a high TRL level, e.g Horizon 2020 Innovation actions

¹¹⁶ https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund/large-scale-projects_en

¹¹⁷ https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund/small-scale-projects_en

Each CSA should produce as the final output a number¹¹⁸ of sound proposals¹¹⁹ (including detailed plans for scalability, commercialisation, and financial models) to be presented to the IF.

Consortia should mobilise (either through internal competences in the consortia or through outsourcing) the needed expertise for the preparation of sound proposals, keeping in mind the ETS IF evaluation criteria: 1) Project maturity, 2) GHG emissions avoidance potential, 3) Degree of innovation, 4) Degree of technical, financial, and operational synergies within the consortium.

Each proposal should also contribute to the development and operationalisation of a continuous innovation pipeline from Horizon 2020 innovations to deployment. For this, proposals should:

- Work in collaboration with key R&I organisations and industrial associations in their respective areas including Horizon Europe public-private partnerships such as Processes4Planet, Clean Steel, Clean Hydrogen Joint Undertaking, and Clean Energy Transition/Batt4EU.
- Devote sufficient resources to collaborate among the proposals selected in the different areas in particular to organise joint activities to promote the mobilisation of the financial and technical expertise needed for the elaboration of sound IF proposals.
- Organise joint open events within their specific area with key industrial stakeholders to share lessons learnt and to promote synergies between Horizon Europe and the IF (e.g. organising open key information dissemination workshops with a larger group of Horizon 2020 projects).
- Cooperate with IF to seek advice and give feedback on lessons learnt to EU innovation funding opportunities, and to prepare a written report detailing the process and achievements within the respective specific area.

Whilst the topic primarily focuses on supporting the project pipeline from Horizon 2020 to the Innovation Fund, the scope of this topic is not limited to the Innovation Fund, and the promotion of projects to deployment including other relevant funding means either at EU or national/regional levels (such as Regional & Cohesion funds, Recovery and Resilience Facility, Important Projects of Common European Interest) is also desirable.

Communities and Cities

Proposals are invited against the following topic(s):

¹¹⁸ The final number will be decided by the consortia depending on the specific sector and the number of mature projects funded by Horizon 2020.

¹¹⁹ Individual proposals for the IF will not be considered public deliverables to ensure full confidentiality.

HORIZON-CL5-2023-D2-01-08: Driving Urban Transition Co-funded Partnership

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 37.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 37.00 million.
<i>Type of Action</i>	Programme Co-fund Action
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The proposal must be submitted by the coordinator of the consortium funded under HORIZON-CL5-2021-D2-01-16: Co-Funded Partnership: Driving Urban Transitions to a sustainable future (DUT). This eligibility condition is without prejudice to the possibility to include additional partners.</p>
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>The evaluation committee will be composed partially by representatives of EU institutions.</p> <p>If the outcome of amendment preparations is an award decision, the coordinator of the consortium funded under the grant agreement that was established in response to the call topic HORIZON-CL5-2021-D2-01-16 will be invited submit an amendment to the grant agreement, on behalf of the beneficiaries.</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>This action is intended to be implemented in the form of an amendment of the grant agreement concluded pursuant to topic HORIZON-CL5-2021-D2-01-16.</p> <p>For the additional activities covered by this action:</p> <ul style="list-style-type: none"> • The funding rate is 30 % of the eligible costs. • Beneficiaries may provide financial support to third parties

	<p>(FSTP). The support to third parties can only be provided in the form of grants. Financial support provided by the participants to third parties is one of the primary activities of this action in order to be able to achieve its objectives. The EUR 60 000 threshold provided for in Article 204(a) of the Financial Regulation No 2018/1046 does not apply. The maximum amount of FSTP to be granted to an individual third party is EUR 5.000.000. This amount is justified since provision of FSTP is the primary activity of this action and it is based on the extensive experience under predecessors of this partnership.</p> <p>The starting date of the grant awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible (and will be reflected in the entry into force date of the amendment to the grant agreement).</p>
<i>Total indicative budget</i>	The total indicative budget for the co-funded European Partnership is EUR 130 million for the period 2021-2027.

Expected Outcome: This topic is for continuation of the Driving Urban Transition (DUT) co-funded partnership to enable it to roll out its full strategy and action plan and assist cities in their sustainability and climate neutrality transitions and by doing so enable the EU to achieve targets set out by the European Green Deal and fulfil its commitments related to the UN Agenda 2030, the Urban Agenda for the EU, the Habitat III New Urban Agenda and the Paris Agreement, European cities need to engage urgently in sustainability and climate-neutrality transitions.

The partnership is expected to contribute to all of the following expected outcomes:

- Enhanced multi-level cooperation and alignment on R&I on sustainable urban development across and within cities, regions and countries, including international outreach and cooperation with other networks and initiatives.
- Strengthen Europe as a role model for R&I on sustainable urban development.
- Innovative, cross-sectoral and inclusive urban governance, policy and decision-making harnessing the full potential of social science and citizens' engagement in the city making process.
- Sustainable, climate-neutral, safe, resilient, socially inclusive, liveable and attractive neighbourhoods, towns and cities with reduced environmental footprint and enhanced well-being and quality of life for citizens.

- Local authorities, municipalities, business, social partners, civil society, knowledge institutions and citizens empowered with necessary capacity, knowledge, skills and tools to actively engage in sustainability and climate-neutrality transitions.
- Science and evidence-based implementation of the European Green Deal, the Urban Agenda for the EU and other European, national, regional and local urban-relevant policies and strategies.

Scope: The objective of this action is to continue to provide support to the European “Driving Urban Transition” Co-funded Partnership identified in the Horizon Europe Strategic Plan 2021-2024 and first implemented under the topic HORIZON-CL5-2021-D2-01-16: Co-Funded Partnership: Driving Urban Transitions (DUT), and in particular to fund additional activities (which may also be undertaken by additional partners) in view of its intended scope and duration, and in accordance with Article 24(2) of the Horizon Europe Regulation.

The proposal should capitalise upon new collaboration opportunities offered by the Association Agreements to Horizon Europe, the “Climate neutral and smart cities” mission and the global Urban Transitions Mission (UTM) mission of Mission Innovation to enhance its expertise, capacities, critical mass and broaden its geographical coverage and outreach capacity. With respect to the latter, mutually benefitting international outreach, collaboration and cooperation with global and international cities and research funding networks should be pursued to align strategies and research agenda and promote scientific evidence and good practice for urban policy on international level.

Taking into account that the present action is a continuation of the topic HORIZON-CL5-2021-D2-01-16 and foresees an amendment to an existing grant agreement, the proposal should describe plans, activities and initiatives that would enable the DUT to ensure, as appropriate, a seamless pursuance of its strategy, objectives and actions to fill important gaps in knowledge, evidence, innovation, technology, data, capacity and skills, integrated approaches, foster inclusive and participatory governance structures and assist cities at European (and, as appropriate, global level) in designing and implementing their sustainability and climate neutrality transitions.

It should, in particular, describe in detail the additional activities (including additional partners) to be covered by the award, and justify their necessity and added value as compared to currently undertaken ones, whilst accounting for the state-of-progress and the evolution in relevant EU and international policy frameworks and urban initiatives. The proposed additional activities (including additional partners) to be covered by the award should also be presented in a separate document in terms of how they would be reflected in the existing grant agreement.

The proposal should elaborate on modalities to scale-up synergies with the works of the NetZeroCities mission platform and relevant projects such as the CapaCITIES networks, the CRAFT platform, the looming Global Knowledge Exchange Centre and, as appropriate, with the missions supporting TRAMI project, to underpin the implementation of the “Climate

neutral and smart cities” mission and ensure coherence and complementarity of activities and leverage of knowledge and investment possibilities.

Furthermore, concrete actions should be envisaged to enhance collaboration and synergies with other Horizon Europe neighbouring European Partnerships such as Clean Energy Transitions (CET), Built environment and construction (Built4People), Rescuing biodiversity (Biodiversa+), Safe and Sustainable Food Systems, Towards Zero Emission Road Transport (2ZERO), Cooperative, Connected and Automated Mobility (CCAM), EIT Urban Mobility and Water4All.

Interfaces to public procurement and investment programmes and links with Urban Innovative Actions (UIA) under the Urban Agenda for the EU, European Urban Initiative (EUI) under cohesion policy, ESIF, private funds, etc. should be explored to support take-up and larger scale implementation of tested approaches and solutions.

The consortium which applied to and received funding under the topic HORIZON-CL5-2021-D2-01-16 is uniquely placed to submit a proposal to continue the envisioned partnership. Not only did this consortium submit the proposal leading to the identification of the partnership in the Horizon Europe strategic planning 2021-2024, it has so far been implementing the partnership through co-funded calls in the year 2022 based on this planning and further to the HE WP 21/22 topic. In this context, the current consortium has particular expertise in relation to the objectives of the Partnership, the activities to be implemented in particular 2022 and 2023 FSTP calls or other calls/scope of calls clearly required/envisaged pursuant to initial proposal/partnership, and other relevant aspects of the action. In practice, another consortium could not continue the activities of the Partnership underway without significant disruption to the ongoing activities, if at all.

While the award of a grant to continue the Partnership in accordance with this call should be based on a proposal submitted by the coordinator of the consortium funded under topic HORIZON-CL5-2021-D2-01-16 and the additional activities (which may include additional partners) to be funded by the grant should be subject to an evaluation, this evaluation should take into account the existing context and the scope of the initial evaluation as relevant, and related obligations enshrined in the grant agreement.

The Commission envisages to include new actions in its future work programmes to provide continued support to the partnership for the duration of Horizon Europe.

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2023-D2-02

Conditions for the Call

Indicative budget(s)¹²⁰

¹²⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²¹	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D2-02-01	IA	24.00	Around 8.00	3
HORIZON-CL5-2023-D2-02-02	RIA	10.00	Around 5.00	2
HORIZON-CL5-2023-D2-02-03	IA	8.00	Around 8.00	1
Overall indicative budget		42.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹²¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D2-02-01: Advanced materials and cells development enabling large-scale production of Gen4 solid-state batteries for mobility applications (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 24.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Building on the results of earlier research projects on advanced solid-state materials, the objective of this topic is to demonstrate, at cell level, the scale-up of advanced solid-state materials for anodes, cathodes, electrolytes and, where applicable, separators with performances and costs compatible for mobility markets.

Projects are expected to contribute to all the following outcomes:

- The selection of solid-state cell components and architecture (anode; electrolyte, cathode, collector, and interfaces) meeting, by the end of the project, all performance indicators at ambient and operational temperatures necessary for mobility, as following:
 - Safety: with a technology compatible with the level 4 EUCAR at module/pack level for automotive (level 2 for aviation and waterborne applications).
 - Gravimetric and volumetric energy density: > 400Wh/kg and 1000Wh/l.
 - Cycling: up to 3000 cycles at 50% DoD (Depth of Discharge) with a minimum of 500 cycles at 80% DoD.

- o C Rate at charge up to 5 C at 80% SoC (state of charge), or whichever C-rate / SOC combination that would allow < 20mn full capacity recovery; for aviation applications, up to 10C.
- o Materials and cells design with mechanical properties and constraints that enable large scale production processes at a competitive cost, especially in terms of pressure conditions at cell and module level.
- o Atmospheric conditions in factories.
- A demonstration of the selected materials in a State-of-Art benchmark cell (at least TRL5) with at least 1 Ah capacity.
- A competitive cost level towards 75€/kWh at pack level by 2030.
- An optimised environmental footprint of cell materials in terms of carbon footprint and quantity of metals.
- Cell manufacturing processes which allow the fabrication of performant, reliable, sustainable, and affordable solid-state cells, demonstrated at industrial pilot level.
- Cell materials and designs which are compatible with a recycling process that respects the requirements as put forward in the proposed Batteries Regulation¹²².

Scope: Proposals are expected to cover all the following points:

- Develop or leverage the materials-specific models and digital tools for material and cell design to identify the best combinations of materials and speed up the cell optimisation process.
- Ensure high ionic conductivity ($> 0.5\text{mS}/\text{cm}^2$) and stability of the solid electrolyte.
- Integrate high voltage cathode ($> 4\text{V}$) to reach the KPIs for mobility as listed in the Expected Outcomes section.
- Propose and evaluate interfaces and coating solutions especially to suppress dendrite growth and enable a stable solid-electrolyte interphase (SEI) and cathode-electrolyte interphase (CEI).
- Optimise the cell design with respect to all the cell components to meet high energy density objectives.
- Anode current collectors and/or solid electrolyte capable of accommodating volume changes upon charge/discharge.

¹²² COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Demonstrate the potential for scale up of materials, cells and sustainable industrial processing methods with cells reaching a capacity of several Ah, produced in a statistical meaningful number to demonstrate the process repeatability.
- Project publications should adhere to the guidelines for publication of research results, as laid out by the "Batteries Europe - Reporting Methodologies" report, subject to the need to maintain confidentiality for future commercial exploitation.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects should link to ongoing Horizon Europe calls, especially **HORIZON-CL5-2021-D2-01-03: Advanced high-performance Generation 4a, 4b (solid-state) Li-ion batteries supporting electro mobility and other applications** and HORIZON_CL5-2021-D1-01-05 (Manufacturing technology development for solid-state batteries (SSB, Generations 4a - 4b batteries). Projects should also take stock of the outcomes of the projects under call LC-BAT-1-2019 (Strongly improved, highly performant and safe all-solid-state batteries for electric vehicles).

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-02-02: New Approaches to Develop Enhanced Safety Materials for Gen 3 Li-Ion Batteries for Mobility Applications (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Advanced Li-ion batteries with enhanced safety behaviour.
- Advanced materials which lead to improved cyclability (15% increase in cyclability by 2030 compared to 2019 base levels) and operational lifetime (a doubling of lifetime by 2030 compared to 2019 base levels), whilst maintaining competitive performance for cost, energy and power density with state-of-art advanced materials for Li-ion batteries.
- Improved sustainability and recyclability, in line with the recycled content, recycling efficiency and material recovery targets included in the proposed Batteries Regulation¹²³.
- A defined concept for demonstrable, highly sustainable, circular manufacturing for the selected advanced materials at Gigafactory scale, with sustainability measured in terms of recognised economic, environmental, social and ethical metrics.
- The improvement in safety has to be demonstrated at representative cell level for mobility applications by direct comparison with SOA Gen. 3 cells tested at the beginning of the project.
- A EUCAR Hazard Level of 3 or other equivalent mobility standard should be validated.

Scope: This topic aims at developing safer materials for high-performing cells by targeted modification in main cell components, namely the cathode, anode, separator and electrolyte. Solutions to common safety hazards have to be covered through a comprehensive design of new materials for at least three of following components:

- New cathode materials with no exothermal decomposition/reactions, reduced probability for oxygen and other gasses release, and preventing corrosion at current collector. Development can include the following approaches/strategies at different levels:
 - o Doping strategies or surface coating materials leading to more robust and effective cathode electrolyte interphase (CEI).
 - o Design of high-capacity cathode materials based on safer chemistries (e.g. stabilized Li-rich layered oxides, disordered rock salts, polyanionic materials...).
 - o Design high-voltage cathodes and high voltage anodes in order to combine them in a high energy cell, with sufficiently high operating voltage to avoid stripping/plating of lithium.

¹²³ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Innovative approaches of cathode structuring to mitigate heat generation, including with toxic gas releases, in abuse conditions.
- New stable anode materials and electrode designs with non-swelling, or low degree of expansion over the whole cell lifetime, with no decomposition/exfoliation, high resistance against Li-dendrite formation – specially at high anode rate capabilities, and favouring the formation of a thermally stable, and low-resistivity SEI. Development can include the following approaches/strategies at different levels:
 - Design and development of new systems with higher standard potential compared to lithium stripping/plating. (High SiO_x, Si/C, etc. content).
 - Surface coating materials for more robust and effective SEI.
 - New approaches to minimize material/anode swelling and expansion during cycling, including anode manufacturing (polymeric and ceramic coating-based approaches, etc.) and structuring the anode-current collector interface.
- New electrolyte formulations with shear thickening, flame retardant and over-charge/discharge properties, maintained high ionic conductivity, broad electrochemical stability i.e., voltage-operating window, and high onset point for Li-dendrite formation, SEI decomposition and CEI effectiveness. Development can include the following approaches/strategies at different levels:
 - (Multi-)functional additives for SEI and CEI stabilisation and protection on anode and cathode such as flame-retardant additives or solvents, ionic conductivity boosters, stability window promoters, etc.
 - Addition of selective particles (i.e. oxides, etc.) to hinder mechanical abuse and improve shear thickening behaviour.
- New separator materials with flame retardant and improved ion transport capabilities, high melting point, and mechanical stability
- New binder materials with thermal, mechanical and electrochemical stability (self-healing systems), low ionic and electrical resistance, improved adhesion and cohesion, and preventing swelling and porosity reduction in electrodes.

Projects need to justify the relevance of the selected components which will be addressed and how the new materials, and the combination of them, will lead to better safety outcomes. To the extent possible the safety and sustainability of developed materials should be assessed in alignment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹²⁴.

¹²⁴ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for ‘safe and sustainable by design’ chemicals and materials.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D2-02-03: Creating a digital passport to track battery materials, optimize battery performance and life, validate recycling, and promote a new business model based on data sharing (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible</p>

	costs.
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Expected Outcome: Stakeholders engaged with the battery value chain need to be provided with accurate, reliable and immutable battery information e.g. related to ESGE (Environmental, Social, Governance & Economic) indicators and monitor thermal runaway at any stage of the value chain. Furthermore, the proposed Batteries Regulation¹²⁵ and future regulations will extend the due diligence to all domains of the battery value chain in the upcoming years. The EU Data Strategy is setting a clear architectural approach to federated data and is enabling a great opportunity to boost the EU dataspace on batteries.

The availability of shared, interoperable, and trusted data for improving recycling and second life application might promote new business, assuring workforce and transportation safety. Indicators such as SoH (State of Health), SoS (State of Safety), SoP (State of Power) should be calculated in accurate, reliable, immutable, and standardized way, based on historical data (usage profile, working temperatures, etc.) of the battery or cells.

The project is expected to contribute to the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting resource efficiency.
- A Digital Product Passport (DPP), a proper tracking and blockchain solution, DLT (Distributed Ledger Technology)-solution or an equivalent solution that allows for built-in data authenticity verification, along the value chain, with no data duplication, avoiding data manipulation assuring privacy by design, with a low power consumption and promoting data interoperability.
- A set of transparent calculation methods for the relevant battery indicators stored in the DPP, which can be used as a base to set future standards.
- A demonstration of new business models in the different parts of the battery value chains and of circular data extraction, based on data sharing.
- The improvement of the battery transportation and workforce safety.
- A solution which has been tested throughout the entire battery value chain.
- At least 2 real life pilots capable to exploit data generated by DPP and to test two of the innovative solutions proposed.

The project is also encouraged to address some of the following outcomes:

- Improvement of the recycling efficiency (more than one material).

¹²⁵ COM(2020) 798 final, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

- Promotion of sustainability and circularity through the adoption of 4R methodological approach Reduce, Repair, Reuse, Recycle.
- Boost of the use of recycled and reusable material to reduce energy usage/CO2 footprint.
- Increase of competitiveness of the European battery industry across the value chain (from mines and refiners to cell manufacturers to cell integrators).
- Streamlined compliance with the proposed Batteries Regulation and EU federated dataspace.

The project outcomes are expected to:

- Be applicable to 3 or more use cases among the main transport or mobile applications (such as road, waterborne, airborne and rail transport, as well as non-road mobile machinery and industrial applications), with the aim to maximize the impact on the European industry.
- Also be applicable to stationary energy storage applications.

Scope: The project is expected to:

- Promote the adoption of a downstream development and implementation of a battery pack Digital Product Passport (DPP) at minimum subset design system level addressing raw materials (at least anode and cathode critical raw materials), cells and modules, which is both scalable and energy efficient.
- Be able to facilitate real-time data recognition for different indicators and at local device - even when the battery ceases to be part of the Energy Storage System (ESS).
- Consider the key performance indicators proposed by Batteries Europe or by the dedicated Partnerships, reflected in the Partnership Strategic Research Agenda (SRA), to guide the technology developments on the application segments and use cases that will be selected. Contribute to the related regulation standards.
- Engage a variety of stakeholders along the whole battery value chain to assure the continuous traceability and assure that accountability will not be lost from raw or recycled raw material to first and second life and recycling.

The suggested blockchain, DLT, or equivalent, solutions are requested to demonstrate trustworthy tracking. The project is encouraged to:

- Validate its interoperable data sharing strategy by adopting a unique battery data space and testing of interoperability between different subsystems (mobility, energy, etc.) is encouraged.
- Develop a safety second life-battery certification protocol, and hazard alerts system to assure liability and protection during transport, and second use.

- Validate new business models, capable to demonstrate improvement in remanufacturing, repurposing and recycling.
- Aim for cross-sectorial applications
- Focus on the lithium-ion battery chemistries currently on the market - or reaching the market in the short term, with the potential to quickly adapt to next-generation battery chemistries and assess its safety tracking.

Projects need to be compliant with the following EU strategy and regulations framework:

1. Green Deal and in particular Circular Economy Action Plan's Sustainable Product Initiative,
2. the EU Digital strategy's Circular Electronics Initiative and,
3. the EU Data strategy,
4. Upcoming regulation on Batteries.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Proposals should interface with the project(s) funded under the topic DIGITAL-2021-TRUST-01-DIGIPASS "Digital Product Passport: sustainable and circular systems" and notably its activities regarding batteries. They should also establish cooperation and complementarity with the selected proposal under the topic HORIZON-CL4-2022-RESILIENCE-01-05 "Technological solutions for tracking raw material flows in complex supply chains", which is tracking raw material flows for batteries value chains and others.

They should furthermore establish collaboration with the partnership "Battery Passport" under the Global Battery Alliance¹²⁶. In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA, Japan and South Korea.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability, performance or safety.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

Call - Cross-sectoral solutions for the climate transition

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¹²⁶ <https://www.globalbattery.org/battery-passport/>

Conditions for the Call

Indicative budget(s)¹²⁷

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²⁸	Indicative number of projects expected to be funded
		2024		
Opening: 07 Dec 2023 Deadline(s): 18 Apr 2024				
HORIZON-CL5-2024-D2-01-01	RIA	16.00	Around 8.00	2
HORIZON-CL5-2024-D2-01-02	IA	21.00	Around 7.00	3
HORIZON-CL5-2024-D2-01-03	RIA	5.00	Around 5.00	1
HORIZON-CL5-2024-D2-01-04	RIA	10.00	1.50 to 2.50	5
HORIZON-CL5-2024-D2-01-05	RIA	20.00	Around 20.00	1
Overall indicative budget		72.00		

General conditions relating to this call

<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.

¹²⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹²⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D2-01-01: Advanced sustainable and safe pre-processing technologies for End-of-Life (EoL) battery recycling (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The pre-treatment process is the first and indispensable step in recycling Lithium-ion batteries (LIBs), which significantly affects the recycling rate of the spent devices and the extraction rate of the high-value metals in the subsequent metallurgical processes. The batteries also contain toxic chemicals, which should be preventatively separated to promote environmental protection and sustainability. Moreover, the pre-treatment processes also help to reduce the scrap volume and allow the separation of the battery components.

Projects are expected to contribute to all of the following outcomes:

1. A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular economy.
2. The direction of the EU battery industry towards the zero-waste concept by developing holistic, materials and energy efficient recycling processes that can increase the content of recovered mass and by improving the cooperation between recyclers and battery manufacturing through a vertical integration strategy, for those cases where battery and/or component repurposing is not a viable option.
3. The circularity of battery materials, where also non-metallic elements (electrolyte, solvent, salts and polymers) are recycled back to use (as raw materials or valuable chemicals). The “cradle to cradle approach” will be addressed through waste pre-treatment by safe and sustainable separation and recovery.
4. Environmentally beneficial processes for battery pre-treatment (pre-processing and separation) of the main elements to decrease the CO₂ footprint and other emissions of the recycled materials.
5. Safe technologies aimed at improved recovery yield, increased quality and purity level of the recycled/recovered materials, improved impurity removal.

Scope: The current EOL LIB recycling technologies are focused on improving the recovering efficiency of Cobalt that is the most valuable material. However, other no-Co battery contents need to be extracted in one go to develop recycling processes with economic, societal and environmental perspectives. They, for instance, include low-density plastics, metal shells and foils, binders, separators, organic solvents, Li salt, anode active materials. Successful separation methods have the potential to enrich the constituent of targeted materials and improve the profit for recycling.

In recent years, several pre-treatment processes were tested at least at lab-scale (usually mechanical, thermal and chemical options). The goal is to develop and integrate new advanced pre-processing concepts that enable more efficient and safe technologies for recycling EoL LIBs. Substantial improvements should be achieved in the processes environmental and economic viability and in the circular economy, narrowing the sustainability gaps in the whole battery recycles pre-treatment.

The following pre-treatment concepts are expected to be addressed:

1. Battery sorting at component level that should be more efficient, accurate, also including recommendations for the standardisation of labelling of battery components, due to the huge variation of physical configurations, cell types and chemistries, with the aim of re-using the suitable components.
2. Advanced pre-processing methods including (but not limited to) physical, mechanical, dry, thermal and aqueous pre-treatment methods that allow improved pre-concentration while minimising as much as possible waste side products.

3. Process design enabling the recovery and valorisation of anode materials.
4. Electrolyte valorisation through the development of sustainable and safe processes for the recovery of Li-salts.
5. Separation of all the strategic battery materials that should be integrated into existing/innovative recycling processes to mitigate potential effect of impurities.
6. Recovery of electrode current collectors (Al and Cu) that should be improved by developing more efficient separation methods of the metal foils from the electrode materials and easier removal of the organic binder.
7. Other recoverable not-active materials from the EoL battery (solvent as EC, DEC, DMC, binders, separator).
8. Pre-assessing concepts by their life cycle sustainability and safety impacts and studying overall techno-economical solutions for recovery systems in order to minimize cost, environmental impact and system losses.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Pre-treatment should not impede on second life, according to the principles of the waste hierarchy.

The topic will generate insights that may be of use for on-going research and innovation on new recycling processes and concepts from topic HORIZON-CL5-2023-D2-01-02.

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-02: Non-Li Sustainable Batteries with European Supply Chains for Stationary Storage (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately.

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<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 21.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs. Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹²⁹ .

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials.
- Development of post-lithium cell chemistries with target cell- and system-level cost, safety, energy density and power metrics suitable for the selected stationary energy storage markets.
- Credible projected storage costs of less than 0.05 €/kWh/cycle by 2030, particularly for applications with a (minimum) storage durations of up to 8 hours.

¹²⁹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Set out a clear route to a feasible, European-based supply chain that reduces reliance on critical raw materials, substituting with abundant, non-toxic, inherently safe raw materials and minimises the impact of possible international trade disruptions and customs tariffs, taking account of the requirements for a range of stationary storage use cases.
- Demonstration of system operated in end-user conditions for at least 3,000 hours.
- Projected product cycling life 5,000 cycles in conditions operating conditions typical of the selected application.
- A battery storage solution, that works safely and efficiently across a wide range of ambient conditions.
- A defined concept for demonstrable, highly sustainable, circular manufacturing for the selected battery type, with sustainability measured in terms of recognised economic, environmental, social and ethical metrics.

Scope: Non-lithium-based batteries have the potential to provide solutions for integration of renewables by providing energy storage solutions, either stand-alone, or as part of larger grid. Proposals are invited for projects which advance the development of non-Li battery systems, show their potential to be manufactured at scale at a cost the market will bear, and which meet regulatory requirements (including regulations for the recycling/re-use of batteries).

Projects may target any stationary storage applications, from a few kWh in small-scale domestic behind-the-meter units, to many MWh in large utility-scale front-of-meter installations.

Whilst stationary storage packaging constraints may not be as stringent as mobile applications in terms of volume and mass, total cost (€/kWh/cycle) and safety are critical to proving technological and commercial viability. Safety concerns become especially prominent as installation sizes increase due to the huge amount of stored chemical energy.

This topic is open to all non-lithium battery chemistries.

Projects are expected to:

- Develop and demonstrate sustainable and safe non-lithium battery solutions from abundant, non-toxic raw materials, capable of deployment in a large share of stationary energy-storage markets aligning the safety and sustainability assessment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹³⁰.
- Develop and demonstrate an innovative non-lithium battery technology with energy density and power metrics suited to stationary energy storage applications; and

¹³⁰ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials.

- Prove the battery system's sustainability and compatibility with a European supply chain.
- Risks will be demonstrably managed to the lowest possible level and within standard acceptable societal limits for toxicity and safety.

Projects are encouraged to:

- Develop new materials that improve techno-economic performances and/or the ability to meet sustainability targets.
- Show how cell and system design and material improvements optimise techno-economic performance by defining (i) technical and commercial targets, and (ii) quantified success criteria/KPIs by which progress toward achieving the targets may be evaluated during both development and validation phases of the project.
- Demonstrate a credible commercial and technical path, from end-of-project outcomes to a stationary-energy-storage product, and which takes account of future manufacturing and recycling requirements.
- Provide evidence of current and future sustainability, viable European supply chains and rigorous analyses of the complex sustainability and recyclability issues including compatibility with regulation, including recycling regulations.
- Demonstrate minimal towards no maintenance requirements.

BMS development is within scope where relevant but should not be the main focus of the project. In any case, developments of the BMS need to take into account the renewable energy directive and any pending amendments, notably for the requirements for real-time access to the data of the BMS.

Projects which, in addition, demonstrate the suitability of the solution under development for other emerging energy storage markets, such as motive power for off-road and transport applications with similar system requirements are encouraged.

Projects focussed on materials discovery for novel chemistries are out of scope. However, material refinements of known chemistries undertaken to achieve performance, sustainability, safety and cost targets are in scope.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals should indicate to which chapters of the Strategic Research and Innovation Plan for chemicals and materials¹³¹ they will contribute.

In order to achieve the expected outcomes, international cooperation is encouraged for use cases, particularly with India, Africa and Australia.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-03: Development of technical and business solutions to optimise the circularity, resilience, and sustainability of the European battery value chain (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected contribute to all the following outcomes:

- A European economic base which is stronger, more resilient, competitive and fit for the green and digital transitions, by reducing strategic dependencies for critical raw materials by promoting a circular approach to manufacturing and resource efficiency.
- Advancing circular and sustainable design and business practices relating to advanced batteries and associated value chains.

¹³¹ https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

- Improving the life cycle sustainability performance of batteries produced in the EU, both in terms of reducing environmental impacts and maximising socio-economic benefits, including increased closed-loop practices.
- Enhancing European strategic independence in terms of battery raw materials, the competitiveness of European industry, and maximising socio-economic benefits at the EU level and beyond.
- Supporting the achievement of established EU recycling efficiency targets for 2030 and beyond.

Contribution to the following outcomes is optional, depending on the scope of the project:

- Enabling tools and best practice for multiple industry sectors in order to improve the European industrial ambitions and global leadership beyond batteries.
- Improving batteries and their materials/components circularity through the promotion of more material efficient designs by enabling longer material/component lifetimes, improving added-value remanufacturing, refurbishing (including exchangeable battery systems), repairing and recycling and ultimately decreasing the cost of using secondary materials/components in batteries.

Scope: Proposals should cover at least two of three scope categories (business models, cross-industry tools, sustainable design) and at least three bullet points in total:

- Business models
 - o Definition of assessment approaches for sustainable business models, including value proposition, value creation and delivery and value capture including environmental, social and economic dimensions. This activity will include analysis of best practice examples for sustainable business models.
 - o Development of sustainable business methods for technical, economic, and environmental evaluation of cycle life options: retrofit, second life, and recycling.
 - o Development of new business models and social innovations that promote the sustainable mobilisation of resources.
 - o Development of business methods to address outstanding issues, such as on-liability, across applications.
- Cross-industry tools
 - o Quantitative methodologies and tools that enable understanding whether recycling or second life is the preferred sustainable option, and at which level (pack, cell, electrode, material) recycling should be deployed.

- o Optimisation of design and operation using LCA. Using high-quality data, exploring trade-offs between i) impacts at fabrication stage, ii) design for durability, iii) energy usage, iv) other functional aspects such as optimal sizing, hybridisation, electronic management, thermal management.
- o Development of a central data information system and database (users of resources can see who offers which type and amount of battery system) and prototype Europe-wide information system for accident vehicles and their available battery systems for re-use.
- Sustainable design
 - o Innovations in battery design and architecture at all levels (system, pack, cell) supporting dismantling and recycling at the end of life. These could include the choice of materials and assembly methods and should not compromise the performance.
 - o Design of innovative sourced materials for improving sustainability in batteries by sustainable processes that avoid toxic/dangerous solvents and require controlled environments.
 - o Research and design of batteries from recycled materials and fully recyclable.

Cooperation with complementary projects launched specifically in the Cluster 5 work program and specifically, in the Destination “*A competitive and sustainable European battery value chain*” is required. Examples of collaborative activities includes information sharing, promotion of results at thematic transnational events, conferences and open webinars.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Projects may collaborate and/or contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08.

Proposals could consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consists of providing added value regarding various aspects of battery sustainability.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-01-05: Furthering the development of a materials acceleration platform for sustainable batteries (combining AI, big data, autonomous synthesis robotics, high throughput testing) (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Admissibility conditions</i>	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 60 pages.
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B.

Expected Outcome: Batteries have complex and dynamic processes taking place in and between materials and at the interfaces/interphases within a battery cell. For each new battery chemistry explored, new challenges in understanding these processes are revealed. To accelerate the finding of new materials and their combinations for both existing and future battery chemistries the iterative and fragmented trial and error approach used today needs to be replaced since it is slow and insufficient.

To accelerate the discovery of battery interfaces, materials and new sustainable concepts with high energy and/or power performance there is a need to develop a fully autonomous and chemistry neutral Materials Acceleration Platform (MAP) for battery materials and interfaces. This is a key and long-term challenge for European battery community. The aim is to integrate advanced multi-scale computational modelling, materials synthesis, characterisation and testing to perform closed-loop autonomous materials findings and interphase engineering that would accelerate by at least a factor of five the discovery of new battery chemistries with ultra-high performances.

Building upon the shared data infrastructure, standards and protocols developed in the BATTERY 2030+ initiative, this call topic addresses the need of increasing the level of autonomy in the MAP-based discovery and development process. The proposal should also cover the contribution and collaboration to the BATTERY 2030+ large scale initiative.

Project results are expected to contribute to all of the following expected outcomes

- Develop new tools and methods for significantly accelerating the development and optimisation of battery materials and interfaces, in order to increase the competitiveness of the battery material and cell industry in Europe.
- Demonstrate a fully autonomous battery-MAP capable of integrating computational modelling, materials synthesis and characterisation of both Li-ion and beyond Li-ion chemistries.
- Scale-bridging, multi-scale battery interface models capable of integrating data from embedded sensors in the discovery and prediction process, e.g. to orchestrate proactive self-healing.
- Community wide state-of-the-art collaborative environment to access data and utilise automated workflows for integrated simulations and experiments on heterogeneous sites, e.g., exploiting European HPC architectures and Large-scale facilities in collaboration with LENS and LEAPS.
- Demonstrate a robotic system that is capable of material synthesis for inorganic, organic or hybrid compounds following standard synthesis routes via automated characterisation of intermediate and final products and autonomous decision-making.
- Deploy predictive hybrid physics- and data-driven models for the spatio-temporal evolution of battery interfaces and demonstrate inverse design of a battery material/interface.

Scope:

- Infrastructure tools for secure remote data access, data analysis and predictive modelling: Develop a FAIR¹³² data infrastructure for raw and curated experimental and modelling data, which can be accessed remotely and securely by relevant stakeholders, including industry. Develop the software infrastructure required to operate this platform, also with regard to future reproducibility and further exploitation of the results of the research activities. The software should provide specific access right and allow remote data access, complemented by distributed workflows using software-agnostic workflow engines that provide rapid-prototyping. Inverse materials design using hybrid physics- and data-driven battery interface genome models should also be demonstrated.

¹³² FAIR (Findable, Accessible, Interoperable, Reusable)

- Automated high throughput characterisation and integrated experimental and computational workflows: High throughput, multimodal operando experimental techniques using standardised battery cells and established protocols should be optimised to perform effective screening of new materials and on-line diagnosis of realistic devices. A central objective is to establish, structure, operate and dynamically refine such facility platform to harmonise, mutualise and optimise the global demand for battery characterisation. This includes automated experimental and computational workflows and modules for data acquisition and multimodal/multiscale analysis. Particular attention should be paid to battery interfaces and direct observation of interfaces under dynamic conditions, which are key to improve the performances and the lifetime of batteries.
- Autonomous synthesis robotics and orchestration software: The transition from low/no automated robotics for the synthesis of battery materials requires several R&I steps towards fully autonomous systems. Within the scope of this proposed call are partially autonomous systems following standard synthesis routes for inorganic and organic battery materials, especially also multi-step and high-temperature synthesis, that so far are challenging to automate for high throughput. AI-based orchestration and optimisation software modules and packages specifically targeting battery materials and interfaces are also central to the scope.
- Inverse design and AI-assisted scale-bridging models for multiple time- and length-scale processes: To develop scale-bridging models correctly describing the multiple mechanisms occurring at atomistic scale and the mesoscopic scale on the cell level. The new model approaches should be able to incorporate data from the advanced sensing in virtual design optimisation and battery control algorithms for SoX estimation. Sensitivity analysis and uncertainty quantification of the developed SoX models is also a requirement to assess the robustness of the developed models. These models should achieve a challenge based rational balance of accuracy and computational effort. They should accurately describe the actual state of the system, but also enable diagnosis and prediction, e.g., when self-healing procedures should be initiated. Multiscale Modelling approaches should be developed for the control of safety between BOL (Beginning Of Life) and EOL (End of Life) of a battery system by different uses and diagnosing the safety state of a battery system by innovative methods.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

Emerging breakthrough technologies and climate solutions

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D2-01-04: Emerging energy technologies for a climate neutral Europe

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 1.50 and 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to **all** of the following expected outcomes:

1. Demonstration of knowledge and scientific proofs of the technological feasibility of concepts on high risk/high return (i.e. high technological and economic risks) technologies for transition to climate neutral economy by 2050 and beyond.
2. Assessment of environmental, social, and economic benefits to contribute to R&I strategy, as well as the EU climate and energy targets.
3. Contribution to establishing a solid long-term dependable innovation in Europe.

Scope: This topic focusses on the development of novel bottom-up technological solutions with breakthrough potential across all parts of the **energy sector value chain**, as well as all energy-related aspects in the **transport sector**.

Projects supported under this topic **should** consider at least **one** of the following areas:

- Energy distribution and transmission.
- Long-term energy storage.
- Novel energy generation/conversion methods.

The **following areas should not be covered**, as they fall within either partnerships or other calls:

- Renewable energy technologies covered under the call D3-1-49 on ‘Next generation of renewable technologies) and renewable hydrogen production.
- Batteries and especially long-term electricity storage technologies, covered under D3-2-17 as well as flow batteries.
- Material research.

The proposal should: i) present a robust research methodology including ambitious yet realistic conversion efficiency targets to be validated in the lab ii) establish the technological feasibility of the proposed concept iii) include a proper assessment of environmental, social, and economic benefits and iv) consider the applicability of the proposed technology in various sectors.

Proposals are expected to fulfil the following conditions:

In developing its concept, the proposal **should** address the following aspects:

- Low environmental impact (e.g. on climate change and pollution) quantified based on Life Cycle Assessment (LCA) framework.
- Barriers to the deployment of such technologies, including issues related to social acceptability or resistance to new energy technologies, related socioeconomic and livelihood issues globally.

Prospective life cycle approach to be done with the relevant information that can be gathered at such TRL level.

Call - Cross-sectoral solutions for the climate transition

HORIZON-CL5-2024-D2-02

Conditions for the Call

Indicative budget(s)¹³³

Topics	Type of	Budgets (EUR	Expected EU contribution per	Indicative number
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¹³³ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

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	Action	million)	project (EUR million) ¹³⁴	of projects expected to be funded
		2024		
Opening: 07 May 2024 Deadline(s): 05 Sep 2024				
HORIZON-CL5-2024-D2-02-01	IA	8.00	Around 8.00	1
HORIZON-CL5-2024-D2-02-02	RIA	15.00	Around 5.00	3
HORIZON-CL5-2024-D2-02-03	IA	16.00	Around 8.00	2
Overall indicative budget		39.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

A competitive and sustainable European battery value chain

Proposals are invited against the following topic(s):

¹³⁴ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

HORIZON-CL5-2024-D2-02-01: Sustainable high-throughput production processes for stable lithium metal anodes for next generation batteries (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: As Li metal anodes will be needed for the Gen 4b, Gen 4c and Gen 5 batteries, it is important to create a European production chain for their manufacturing, in order to guarantee secure supply chains for the next generation battery producers with a focus on high performance and recyclability for Gen 4b, Gen4c or Gen5 cells.

The proposed project is expected to contribute to all the following outcomes:

1. Reduction of strategic dependencies for critical raw materials by promoting resource efficiency.
2. Energy consumption/carbon footprint of processing 10% lower than SoA.
3. Throughput of Li foil and/or electrode production to support cell manufacturing, including a technical pathway towards production at MWh/(sub-)GWh scale.
4. Ensure stability of Li during handling, processing and operation using coatings or other protective technologies (e.g. barriers/protective layers).

5. Processing of Li (Metal) and Li electrodes within cell assembly at industrial scale, including, but not limited to, high-quality cutting of the Li foil and/or electrode.
6. Homogeneous Li films with thickness below 20µm, contributing towards energy density levels of 400-500 Wh/kg.
7. The developed process should be compatible with recycling targets (with respect to purification of scrap with protective coating) and assure recyclability to more than 70% of Li metal in battery waste, (90% Li metal for production scrap).
8. The proposed project is encouraged to contribute to a competitive price of 75€/kWh at pack level.

A demonstration of the performance of Li at cell level in SoA benchmark cell (at least TRL5 with at least 1 Ah capacity). Validation in Generation 4b, 4c and/or Generation 5 cells is highly encouraged.

Scope: Proposals under this topic are expected to cover all of the following bullet points:

- Sustainable, cost-efficient and large-scale production of Li-metal foils and/ or electrodes, demonstrated up to pilot level during the project. Activities can include, but are not limited to, extrusion, comparison extrusion / electrostatic spray, rolling and co-rolling. However, extensive cell design and development are out of the scope as this topic focuses on the Li anode production.
- Control of the passivation of Li metal films, and to understand how the passivation is linked with the dry room conditions and requirements. The goal is to find the optimal way: high passivation and lower quality dry room, or low passivation and higher quality dry room, and how these selections are linked with cost, energy consumption and performance of the cells.

The project is expected to also guarantee safety of the Li film production and handling, which has to be demonstrated in a process that is compatible for large scale production.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan).

Collaboration with other projects from calls HORIZON-CL5-2023-02-01 Advanced materials and cells development enabling large-scale production of Gen4 solid-state batteries for mobility applications and/or HORIZON-CL5-2024-02-02 Post-Li-ion technologies and relevant manufacturing techniques for mobility applications (Generation 5) is expected.

The project is encouraged to cooperate with projects stemming from call topic HORIZON-CL5-2023-01-01 Technologies for sustainable, low carbon and cost-efficient downstream processing and production of battery-grade materials.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-02-02: Post-Li-ion technologies and relevant manufacturing techniques for mobility applications (Generation 5) (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: This topic aims at developing:

- Generation 5¹³⁵ technologies for mobility applications;
- the relevant manufacturing techniques which are affecting performance, safety and costs;
- Cell designs which will allow for full and easy recyclability at the end of their life.

This topic also aims at evaluating the possible manufacturing compatibility with existing lithium-ion production infrastructure.

Projects are expected to contribute to at least one of the following outcomes:

- Conversion systems based on metallic anodes with enhanced safety, delivering on cost, performance, sustainability and recyclability, with clear prospects for the feasibility of the scale-up of the manufacturing processes.

¹³⁵ As defined in the Batteries Europe Strategic Research Agenda https://ec.europa.eu/energy/sites/ener/files/documents/batteries_europe_strategic_research_agenda_december_2020_1.pdf

- Metallic anode protection and/or activation for conversion systems (polymer, ceramic and hybrid electrolytes) with increased safety, cycle life and low cost.
- Post lithium-ion cells based on cations other than lithium with long cycle-life (Sodium-ion is excluded and covered by topic HORIZON-CL5-2024-D2-01-02).

In addition, projects are expected to contribute to creating rechargeable batteries that will work in realistic environments, are recyclable and with low environmental impact, and have safe manufacturing processes. To the extent possible the safety and sustainability of developed materials should be assessed in alignment with the Commission Recommendation on safe and sustainable by design chemicals and materials¹³⁶.

Translating these outcomes into indicative KPIs to guide the R&I efforts, projects are expected to show a credible technical pathway to achieve all the following targets by 2030 and beyond:

- A safe behaviour at cell level: expected EUCAR Hazard level below 4 for automotive; level 2 for aviation and waterborne applications;
- Specific energy at cell level targeting 500 Wh/kg, and volumetric energy density at cell level targeting 600 Wh/l;
- Charge and discharge with a C-rate between 2 and 10;
- 800+ cycles at 50%DoD or 400 cycles at >80%DoD;
- Cost at cell level < 75 euro/kWh.

Scope: Proposals should address improvements in sustainable materials designs¹³⁷ to reach the manufacturability and high safety of the selected technology.

Successful projects are expected to cover at least three of the following bullet points:

- Improvement of materials:
 - Scalable and manufacturable surface coating materials for metallic anode protection and/or activation (e.g. CVD, PLD, ALD...) to increase safety and cycle life.
 - Binders with high chemical and thermal stability to reduce toxicity and enable the use of water-based manufacturing processes.

¹³⁶ Commission Recommendation (EU/2022/2510) establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials.

¹³⁷ The future Commission initiative for Safe and Sustainable by Design [Reference to updated industrial research site on Europa.eu to be added which will link to the relevant Commission documents. Already available 'Review of safety and sustainability dimensions, aspects, methods, indicators, and tools', under consultation 'Framework for the definition of criteria and evaluation procedure for chemicals and materials'.] will set a framework for assessing safety and sustainability of chemicals and materials and should be considered as a baseline for proposals.

- o Design and development of new cell technologies with higher capacities compared to Li-ion cells.
- o Improve and increase the electrodes-electrolyte compatibility with additives to increase over cell time.
- o Improve the understanding of the chemical and/or electrochemical reaction mechanisms using advanced techniques in the cells for Gen5 technologies developed.
- o Improve the insertion cathode with high charge-storage capacity.
- o Use of safe and non-toxic materials.
- o New efficient and sustainable catalysts that can promote polysulfide conversion in Metal-S batteries or the oxygen evolution/reduction reactions in rechargeable Metal-air batteries.
- Design and manufacturing:
 - o Innovative cell design ensuring high performances, low cost and ready for recycling.
 - o Develop relevant manufacturing processes and assess the possible manufacturing compatibility with the existing lithium-ion production infrastructure and production lines.
 - o Proof of concept possibly at small pilot line scale.
 - o Design production with low environmental impact, safe and healthy environment for workers, low energy consumption.

Projects are encouraged to demonstrate also techno-economic suitability of the solution for other emerging markets, such as motive power for off-road applications, or energy storage applications.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation and deployment (feasibility study, business plan).

Projects are expected to collaborate and contribute to the activities of the Coordination and Support Action defined under the topic HORIZON-CL5-2022-D2-01-08, including the definition of a long-term research roadmap for this topic.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D2-02-03: Size & weight reduction of cell and packaging of batteries system, integrating lightweight and functional materials, innovative thermal management and safe and sustainable by design approach (Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Widespread electrification of mobile applications is necessary to achieve the goals of the European Green Deal. A competitive European battery value chain will have to deliver highly performant and safe battery systems in order to enable the necessary uptake of electrified mobility applications.

This topic focuses on delivering a safe and sustainable by design approach for batteries reduced in size and weight which will deliver the performance necessary for mobile applications. The objective is to ruggedise energy storage packs by enlarging the environmental and operational conditions in which they can operate, while maintaining a high level of performance and achieving a reduction in the size and weight of the battery pack.

Successful projects are expected to deliver on both following points:

- An increase of the net useful mass and volumetric energy density of the battery system between 10% and 30% compared to the state-of-the-art battery systems.
- The improvement of the safety by design measures throughout the battery lifetime and during operation.

Projects are furthermore expected to deliver innovative thermal management to

- Increase performance over the complete operational conditions

- Enable fast charging requirements 10%-80% in 10 minutes maximum.

The solutions should be demonstrated and validated at application level and should comply with all relevant standards (performance and safety). They are also encouraged to contribute to standardisation of measures for safe thermal management.

Scope: Projects should achieve size and weight reduction by integrating different technologies such as:

- Integration of advanced cell technologies/generations, sensing technologies,
- The use of lightweight and multi-functional materials (including, but not limited to, the use of nanomaterials) that are safe and sustainable by design in alignment with Commission Recommendation (EU/2022/2510) and lightweight structures for battery casing.
- Improvement of the cell to system ratio by adopting innovative packaging approaches to enable smart battery cell concepts. Approaches to reduce the complexity of HV and BMS architecture and substitution by alternatives.

To reach those targets, improvements in both components in the cell and in the pack will be considered.

Proposals are expected to also address innovations in the manufacturing processes that result in size and weight reduction of the packs.

In addition, projects are expected to improve battery performance and safety by demonstrating innovative thermal management systems, which enhance fast charging capability or high-power application during operational lifetime (heating and cooling).

Finally, projects should enhance the safety throughout the full battery lifetime and for failure conditions by developing and demonstrating safe by design measures, for example such as:

- Thermal propagation measures.
- Fire retardant properties.
- Mechanical properties ameliorations.
- Reliability, default propagation/thermal runaway modelisation and simulation.

The effectiveness of safety measures should be demonstrated by simulation at pack level.

The projects are to focus on the battery system level, i.e., on the integration of battery cells into a battery system (e.g., a battery pack), considering mechanical, electrical and thermal aspects.

The integration of battery systems into larger systems of application (e.g., into vehicles structure) can be part of scope (e.g. cell to casing integration) as long as it can be

demonstrated as a possibility to reduce overall packaging space, battery weight and battery performance improvement.

All solutions are expected to consider optimal design for manufacturing, end of life management and LCA analysis and disassembly.

The Commission initiative for Safe and Sustainable by Design¹³⁸ will set a framework for assessing safety and sustainability of chemicals and materials and which should be considered as a reference in the proposal.

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with the USA.

This topic implements the co-programmed European Partnership on Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership on Batteries (Batt4EU) in support of the monitoring of its KPIs.

¹³⁸ See documents defining the SSbD framework and criteria on: https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en

Destination – Sustainable, secure and competitive energy supply

This Destination includes activities targeting a sustainable, secure and competitive energy supply. In line with the scope of cluster 5, this includes activities in the areas of renewable energy; energy system, grids and storage; as well as Carbon Capture, Utilisation and Storage (CCUS).

The transition of the energy system will rely on reducing the overall energy demand and making the energy supply side climate neutral, in current and future climate conditions. R&I actions will help to make the energy supply side cleaner, more secure, and competitive by boosting cost performance and reliability of a broad portfolio of renewable energy solutions, in line with societal needs and preferences. Furthermore, R&I activities will underpin the modernisation of the energy networks to support energy system integration, including the progressive electrification of demand side sectors (buildings, mobility, industry) and integration of other climate neutral, renewable energy carriers, such as clean hydrogen. Innovative energy storage solutions (including chemical, mechanical, electrical and thermal storage) are a key element of such energy system and R&I actions will advance their technological readiness for industrial-scale and domestic applications. Carbon Capture, Utilisation and Storage (CCUS) is a CO₂ emission abatement option that holds great potential and R&I actions will accelerate the development of CCUS in electricity generation and industry applications.

This destination contributes to the activities of the Strategic Energy Technology Plan (SET Plan) and its implementation working groups.

This Destination contributes to the following Strategic Plan's **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy¹³⁹ by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people;
- Affordable and clean energy.

The **expected impact**, in line with the Strategic Plan, is to contribute to “*More efficient, clean, sustainable, secure and competitive energy supply through new solutions for smart*

¹³⁹ ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

grids and energy systems based on more performant renewable energy solutions”, notably through

- i. Fostering European global leadership in affordable, secure and sustainable **renewable energy technologies** and services by improving their competitiveness in global value chains and their position in growth markets, notably through the diversification of the renewable services and technology portfolio (more detailed information below).
- ii. Ensuring cost-effective uninterrupted and affordable supply of energy to households and industries in a scenario of high penetration of variable renewables and other new low carbon energy supply. This includes more efficient approaches to managing **smart and cyber-secure energy grids** and optimisation the interaction between producers, consumers, networks, infrastructures and vectors (more detailed information below).
- iii. Accelerating the development of **Carbon Capture, Use and Storage (CCUS)** as a CO₂ emission mitigation option in electricity generation and industry applications (including also conversion of CO₂ to products) (more detailed information below).

Global leadership in renewable energy

Renewable energy technologies encompass renewable electricity, renewable heating and cooling and renewable fuel technologies. They provide major opportunities to replace or substitute carbon from fossil origin in the power, heating/cooling, transportation, agriculture and industry economic sectors. Their large scale and decentralised deployment are expected to create more jobs than the fossil fuel equivalent and, especially, local jobs. Renewable energy technologies are the baseline on which to build a European and global climate-neutral future. A strong global European leadership in renewable energy technologies will pave the way to increase energy security and reliability.

It is imperative to enhance affordability, security, sustainability, and efficiency for more established renewable energy technologies (such as wind energy, photovoltaics, solar thermal, bioenergy or hydropower), and to further diversify the technology portfolio. Furthermore, advanced renewable fuels, including synthetic fuels (which contain also direct solar fuels¹⁴⁰) and sustainable advanced biofuels, are also needed to provide long-term carbon-neutral solutions for the transport, energy consuming and energy-intensive industrial sectors, in particular for applications where direct electrification is not a technically and cost-efficient option.

In line with the “do not significantly harm” principle for the environment, research and innovation actions for all renewable energy technologies aim to also improve the environmental sustainability of the technologies, delivering products with reduced greenhouse gas emissions and improved environmental performance regarding water use, circularity, pollution, and ecosystems. For biofuels and bioenergy improving the environmental sustainability is associated to the biomass conversion part of the value chain and the quality of

¹⁴⁰ Direct solar fuels are in this context renewable synthetic fuels made by direct conversion routes from solar to chemical energy

the product, while air pollution associated to combustion in engines falls in the scope of other destinations in Cluster 5 and other environmental aspects will be under Cluster 6.

Synergies with activities in cluster 4 are necessary for integrating renewable energy technologies and solutions in energy consuming industries and ensure that renewable energy solutions do not harm the environment. Complementarities with cluster 6 concern mainly biomass-related activities and with EIC low technology readiness level actions.

All renewable energy technologies are addressed as they have all a strong international market potential, and it will be coherent with the EU policy of industrial leadership worldwide.

Regarding the REPowerEU communication, renewable energy technologies are - as described above - a key instrument to diversify EU gas supplies and reduce the EU's dependence on fossil fuels. Most of the topics in this work programme are centred along two of the REPowerEU tracks, with the remainder of the topics fully contributing to decreasing the EU's dependence on fossil fuels:

- **PV, wind energy and heat pumps**, encompassing the most readily available renewable energy technologies to reduce the EU's dependence on fossil fuels. (17 topics)
- **Renewable fuels**, encompassing the most readily available technologies (advanced biofuels) but also the less mature ones (synthetic renewable fuels). Renewable fuels can be used in transport but also in buildings and industry to meet the demand for electricity and heat, therefore displacing fossil fuels. Gaseous renewable fuels are one of the named actions in the REPowerEU communication, as regards increasing the production of bio methane twice above the European Green Deal target in 2030. All forms of renewable fuels, and in particular advanced biofuels, contribute to reduce the EU's dependence, because they are drop-in fuels and direct replacements of fossil fuels, utilizing the existing infrastructure. (8 topics)
- The remainder of the topics also contributes to the objective of **decreasing the EU's dependence on fossil fuels**, with the focus either on specific renewable energy sectors (bioenergy, geothermal, hydropower, ocean energy and solar thermal) or on cross-technology activities (next generation renewable energy, market measures, international cooperation). (18 topics)

Main expected impacts:

- Availability of disruptive sustainable renewable energy and renewable fuel technologies & systems accelerating the replacement of fossil-based energy technologies to achieve climate neutrality in the energy sector by 2050, considering future climate conditions, and without harming biodiversity, environment and natural resources.
- Reduced cost and improved efficiency of sustainable renewable energy and renewable fuel technologies and their value chains.

- Support de-risking of sustainable renewable energy and fuel technologies with a view to their commercial exploitation to contribute to the 2030 “Fit for 55” targets increasing the share of renewable electricity, heat and fuels in the EU energy consumption (in particular, 40% renewable energy overall, 2.2% advanced biofuels and 2.6% renewable fuels of non-biological origin).
- Better integration of sustainable renewable energy and renewable fuel-based solutions in all economic sectors, including through digital technologies.
- Enhanced security and autonomy of energy supply in the EU, while accelerating the green transition.
- Affordable, secure and sustainable energy solutions to diversify gas supplies in the EU by increasing the level of biomethane.
- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).
- Enhanced sustainability of renewable energy and renewable fuels value chains, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- More effective market uptake of sustainable renewable energy and fuel technologies to support their commercialisation and provide inputs to policy making.
- Increased knowledge on the environmental impacts of the different renewable energy technologies along their lifecycle and value chains.

Energy systems, grids and storage

Main expected impacts:

- Increased resilience of the energy system, based on improved and/or new technologies and energy vectors, to control the system and maintain system stability under difficult circumstances.
- Increased flexibility and resilience of the energy system to plan and operate different networks for different energy carriers simultaneously in a coordinated manner that will also contribute to climate neutrality of hard-to-electrify sectors.
- Innovative data-driven services for consumers that empower them to engage in the energy transition. Enhanced consumer satisfaction and increased system flexibility thanks to enabling consumers to benefit from new energy services and facilitating their investment and engagement in the energy transition.

- Improved energy storage and energy vector technologies, in particular technologies for long-term storage of electricity and heat.
- Foster the European market for new energy services and business models as well as tested standardised and open interfaces of energy devices through a higher degree of interoperability, increased data availability and easier data exchange.
- More effective and efficient solutions for transporting and seamlessly integrating off-shore energy with new electricity transmission technologies, in particular using superconducting technologies, power electronics and hybrid Alternate Current – Direct Current grid solutions as well as MT HVDC (Multi Terminal High Voltage Direct Current) solutions.
- Based on easy data-sharing, increased flexibility of the energy system to integrate renewables, and better predictability of return on investments in renewable and energy efficiency investments.
- Speeding up of (from early-adoption to upscaling) of new digital technologies in the energy sector for the benefit of the energy transition.
- Development of cyber-security and privacy tools and technologies tailor-made for the specific requirements of the energy system.
- Development of technologies and systemic approaches that optimise energy management of IT technologies.

Carbon Capture, Utilisation and Storage (CCUS)

Main expected impacts:

Carbon capture, utilisation and storage (CCUS)

- Accelerated rollout of infrastructure, in particular for CCUS hubs and clusters.
- Continuing knowledge and best practice sharing activities, in particular on connecting industrial CO₂ sources with potential bankable storage sites and installations using CO₂, providing greater confidence for decision makers and investors.
- Proven feasibility of integrating CO₂ capture, CO₂ storage and CO₂ use in industrial facilities and to maximize the efforts to close the carbon cycle. Demonstrating these technologies at industrial scale should pave the way for subsequent first-of-a-kind industrial projects.
- Reduced cost of the CCUS value chain, with CO₂ capture being still the most relevant stumbling block for a wider application of CCUS. Develop innovative technology for CO₂ conversion to reduce the need for pre-concentration and/or purification.

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- Adequate frameworks for Measurement, Monitoring and Verification (MMV) for storage and use projects, to document safe storage and for public buy-in of the technology.
- Further research in DACCS and BECCS as CO2 capture technologies in combination with CO2 storage in order to deliver carbon removals in view of achieving the net zero targets.
- Assess the environmental impacts and risks, in the short, medium and long term, of CCUS technologies, with respect to the Do No Significant Harm principle, and to inter-generational solidarity.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D3-01	401.10	22.50	30 Mar 2023
HORIZON-CL5-2023-D3-02	161.00		05 Sep 2023
HORIZON-CL5-2023-D3-03	64.60		10 Oct 2023
HORIZON-CL5-2024-D3-01		246.00	16 Jan 2024
HORIZON-CL5-2024-D3-02		138.00	21 Jan 2025
Overall indicative budget	626.70	406.50	

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-01

Conditions for the Call

Indicative budget(s)¹⁴¹

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million) ¹⁴²	Indicative number of projects expected to be funded
		2023	2024		
Opening: 13 Dec 2022 Deadline(s): 30 Mar 2023					
HORIZON-CL5-2023-D3-01-01	IA	40.00 <small>143</small>		Around 20.00	2
HORIZON-CL5-2023-D3-01-02	IA	16.00 <small>144</small>		Around 8.00	2
HORIZON-CL5-2023-D3-01-03	IA	14.00 <small>145</small>		Around 7.00	2
HORIZON-CL5-2023-D3-01-04	IA	14.00 <small>146</small>		Around 7.00	2
HORIZON-CL5-2023-D3-01-05	RIA	18.00 <small>147</small>		Around 6.00	3
HORIZON-CL5-2023-D3-01-	IA	18.00		Around 9.00	2

¹⁴¹ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹⁴² Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

¹⁴³ Of which EUR 17.60 million from the 'NGEU' Fund Source.

¹⁴⁴ Of which EUR 8.90 million from the 'NGEU' Fund Source.

¹⁴⁵ Of which EUR 7.80 million from the 'NGEU' Fund Source.

¹⁴⁶ Of which EUR 7.80 million from the 'NGEU' Fund Source.

¹⁴⁷ Of which EUR 10.10 million from the 'NGEU' Fund Source.

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06		148			
HORIZON-CL5-2023-D3-01-07	IA	18.00 149		Around 9.00	2
HORIZON-CL5-2023-D3-01-08	IA	40.00 150		Around 20.00	2
HORIZON-CL5-2023-D3-01-09	IA	12.00 151		Around 6.00	2
HORIZON-CL5-2023-D3-01-10	IA	20.00 152		Around 20.00	1
HORIZON-CL5-2023-D3-01-11	IA	18.00 153		Around 9.00	2
HORIZON-CL5-2023-D3-01-12	IA	22.00 154		Around 11.00	2
HORIZON-CL5-2023-D3-01-13	RIA	14.00 155		4.00 to 5.00	3
HORIZON-CL5-2023-D3-01-14	IA	30.00 156		Around 10.00	3
HORIZON-CL5-2023-D3-01-15	IA	18.00 157		Around 18.00	1
HORIZON-CL5-2023-D3-01-16	CSA	0.60		Around 0.60	1
HORIZON-CL5-2023-D3-01-17	IA	40.00 158		Around 20.00	2
HORIZON-CL5-2023-D3-01-18	COFUND	48.50	22.50	Around 71.00	1
Overall indicative budget		401.10	22.50		

¹⁴⁸ Of which EUR 10.10 million from the 'NGEU' Fund Source.

¹⁴⁹ Of which EUR 10.10 million from the 'NGEU' Fund Source.

¹⁵⁰ Of which EUR 22.40 million from the 'NGEU' Fund Source.

¹⁵¹ Of which EUR 6.00 million from the 'NGEU' Fund Source.

¹⁵² Of which EUR 11.20 million from the 'NGEU' Fund Source.

¹⁵³ Of which EUR 10.10 million from the 'NGEU' Fund Source.

¹⁵⁴ Of which EUR 12.30 million from the 'NGEU' Fund Source.

¹⁵⁵ Of which EUR 7.80 million from the 'NGEU' Fund Source.

¹⁵⁶ Of which EUR 16.80 million from the 'NGEU' Fund Source.

¹⁵⁷ Of which EUR 10.10 million from the 'NGEU' Fund Source.

¹⁵⁸ Of which EUR 22.02 million from the 'NGEU' Fund Source.

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-01: Renewable Energy Valleys to increase energy security while accelerating the green transition in Europe

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 40.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

	additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome:

Project results are expected to contribute to all of the following expected outcomes:

- Contribute to the implementation of the REPowerEU Plan, in particular to i) diversify gas supplies via higher levels of sustainable bio-methane (mainly based on organic waste and agricultural residues) and green hydrogen, and ii) speed up Europe’s path to independence from fossil fuels by increasing the share of renewable energy (electricity, heat and fuels) in the European energy consumption.
- Increase the roll-out of local or regional renewable energy system solutions for electricity, heat and fuel needs and contribute to their market up-take in Europe.
- Create new sustainable jobs linked to local or regional renewable energy system value chains and enhance economic growth in local or regional European communities.
- Enhance security and autonomy of local or regional energy supply in EU Member States/Associated countries in current and future climate conditions.
- Increase the readiness, reliability, performance and affordability of local or regional renewable energy system solutions in Europe.

Scope: The EU energy system strongly relies on centralised electricity generation and on fuel imports, with 95% of its oil and 84% of its gas consumption sourced from outside the EU. The REPowerEU Plan proposes a set of actions to reduce the EU’s dependence on fossil fuels and diversify its energy supply ‘well before 2030’. The three pillars of the plan are to ramp up the production of green energy, diversify our energy supplies, and reduce our demand for fossil gas, coal and oil.

Renewable energy valleys are understood as decentralised renewable energy systems that offer a viable and efficient solution to the challenges mentioned above. For example, local production and consumption, reduced transmission and distribution losses thanks to the reliance on local networks for energy needs, greater operational flexibility and reduced dependence on expensive fuel imports all contribute to a higher energy autonomy, a more secure supply, and lower, more stable overall energy costs, including for individual citizens. In addition, this alleviates a part of the load on the centralised grid and avoids blockages by the capacity of the grid.

Proposals are expected to address the following aspects:

- Creation of a renewable energy valley ‘living lab’ in local, peri-urban or regional communities that demonstrates in real life conditions the sustainable and cost-effective

production and storage of renewable energy from different local renewable energy sources providing multiple renewable energy carriers (e.g., electricity, heat, renewable fuels, bio-methane, biogas, hydrogen), fully covering the local energy needs on an annual basis.

- Consideration of different potentials in terms of geography, climate and natural resources in the concept design.
- Consideration of different end users (e.g. buildings, mobility, industry, industrial parks) of the multiple renewable energy carriers.
- Reduction of energy use and energy losses through the integration of effective and innovative energy-efficient solutions.
- Development and testing of a digital twin of the specific local energy grid for all types of energy carriers (i.e., electricity, heat, fuels including gases) for operational analysis, detailed energy forecasting and local grid management.
- Scenario analysis using the digital twin to constantly improve multiple carrier grid management, planning, data gathering/handling and cyber security.
- Development of cost-effective upscaling and commercialisation approaches of the solutions, linked to robust business models along the value chains, considering inclusive and affordable access to energy for consumers. This can include collaborative ventures with local stakeholders.
- Regarding the development of the renewable energy technologies value chains, fostering the participation of the local industry and other stakeholders, including citizens, Energy Communities and the Energy Communities Repository¹⁵⁹ as appropriate, therefore generating local jobs, skills, economic growth and benefits for citizens. As such, providing support to the participation of citizens in the design, implementation and exploitation of renewable energy, in order to increase acceptability. Where applicable, synergies with other economic sectors than the energy sector may be considered.
- Regarding the local or regional renewable energy system developed, assessment of its stability, robustness, and fitness to the local resources and needs, including understanding consumer behaviour.
- Assessment of costs avoidance from fossil fuels imports in line with REPowerEU to decrease the dependence on such imports.
- Assessment - both at the design phase and during operation - of environmental and socio-economic impacts (positive and negative) for the local community or region, and development of measures to mitigate the negative impacts.

¹⁵⁹

https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

The renewable energy valleys can take diverse configurations, such as peri-urban settings, (agro-) industrial clusters or remote or islanded areas. They can also take the form of either distinct but combined systems or unique poly-generation systems (i.e., in the same infrastructure) to deliver multiple energy carriers from combined renewable energy resources and technologies.

The proposal should indicate how the operation and maintenance of the living lab will be guaranteed after the end of the project.

Technological developments for hydrogen production and storage are addressed in the frame of the Clean Hydrogen European Partnership and are therefore excluded from this call, but proposals may include the integration of such devices in the demonstration.

Proposals are expected to foresee coordination and collaboration with similar EU-funded projects (in particular, those that will be funded under this topic) for policy relevant issues such as regulatory framework, business models and obstacles to innovation.

HORIZON-CL5-2023-D3-01-02: PV integration in buildings and in infrastructure

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic products are considered to be building-integrated, if they have been designed following the basic requirements for construction works in order to form and/or replace a construction product. If the integrated PV product is dismantled, it would have to be replaced by an appropriate conventional construction product. Building and infrastructure integrated PV can be a cost-effective, technologically proven solution to decarbonise buildings and infrastructure.

Consequently, project results are expected to contribute to all of the following expected outcomes:

- Demonstrate economic and sustainable integration of PV products in the built environment and in infrastructure.
- Establish enhanced structural collaborative innovation between PV companies and the (building) construction sector.
- Contribute to the Renovation Wave, the Mission on climate-neutral and smart Cities and the New European Bauhaus initiative.

Scope: PV integration in buildings and in infrastructure unlocks a huge potential for renewable electricity generation. Integrated PV require individual solutions in order to meet multi-functional and aesthetic requirements such as yield-friendly colouring or modular transparency, antifouling property, structural flexibility, module lightness and flexibility, suited voltage levels, the use of and combination with (building) materials other than glass, and an overall high aesthetical value that addresses the requirements of architects and designers.

Proposals are expected to:

- Demonstrate resilience against partial shading, flexibility in the interconnection of PV modules having different sizes and electrical characteristics specific optical and thermal control solutions, long service life/easy replacement, safety and simplicity of maintenance, software control for quick detection of faults, module substructures and fixing systems to enhance aesthetics and functionality of the integration and electricity yield.
- Decrease costs and enhance lifetime, quality, reliability and sustainability with new approaches for both PV module and BOS with the development of industrialized production of customized products and of prefabricated modular solutions, which incorporate an integrated life cycle approach.
- Develop energy integration and social behaviour concepts to maximize the energy matching between PV production and local buildings consumption, supported by new tools and business models to ensure their economic effectiveness.
- Demonstrate integration of PV design and manufacturing within the construction value chain with appropriate consideration to standards for buildings and infrastructure, as well as contribution to new and improved standards.
- Form alliances between all stakeholders (PV and building/construction sectors, distribution system operators, investors, owners, architects, installers) to tackle a number of educational and regulatory barriers that still hinder the development of integrated PV in buildings and in infrastructure. The goal is to promote new concepts/schemes and business models for an active role of integrated PV in renovation and construction.

Demonstrations are expected to be carried out in more than one different construction typologies (residential buildings, tertiary building [hospitals, schools, public administration buildings, etc.]), or civil infrastructures (roadways, noise barriers, parking lots, bridges, etc.) and in more than one location in Europe.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects are expected to contribute to the New European Bauhaus (NEB) initiative¹⁶⁰ by interacting with the NEB Community, NEBLab and other relevant actions of the NEB initiative through sharing information, best practice, and, where relevant, results.

HORIZON-CL5-2023-D3-01-03: Floating PV Systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal to a clean energy system and the achievement of the net zero-emissions target. To this end, it is important to enhance affordability, sustainability and exploit the modularity and synergies of application of PV technologies.

Consequently, project results are expected to contribute to all of the following outcomes:

¹⁶⁰ https://europa.eu/new-european-bauhaus/index_en

- Expand the potential application and minimise the environmental impact of Floating PV (FPV) technology for inland and offshore waters.
- Significant improvement of FPV designs that reduce both CAPEX and OPEX, maximize energy output and thus reduce LCoE.

Scope: Floating PV (FPV) has huge potential in uncovered waterbodies, presenting an opportunity for solar energy production in areas where difficult terrain or land constraints make ground-mounted systems impractical. However, FPV also face a plethora of challenges for various environmental conditions such as wind, wave, currents, water level variations and humid and corrosive environment that could adversely affect the electrical output and life of the plant.

Proposals are expected to:

- Develop (and verify) predictive yield models including dynamic behaviour of the PV floats, temperature effects and wave induced mismatch losses, depending on the application environment (wave height class) and scale of implementation.
- Demonstrate advanced module and system concepts of adequate scale (min 5 MW) for electrical output optimisation considering the disturbance of environmental factors to the electrical output characteristics of PV modules and systems.
- Demonstrate system components that satisfy the structural and functional requirements for the entire lifecycle (coping with soiling and fouling, degradation, corrosion, environmental stress cracking, UV stabilisation, exposure to water, salinity, humidity, algae growth, toxicity). Address reliability and performance loss rates through the development of accelerated stress testing specifically for FPV applications, operational data, and visual inspection of FPV systems.
- Demonstrate low impact on ecosystem biodiversity by developing methodologies (models, monitoring...) and guidelines to assess the direct impacts of FPV on aquatic systems and biodiversity and consider potential mitigation measures.
- Satisfy end-of-life recycling aspects.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2023-D3-01-04: Solar Systems for Industrial Process Heat and Power

Specific conditions	
<i>Expected EU</i>	The Commission estimates that an EU contribution of around EUR 7.00

<i>contribution per project</i>	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Renewable energy integration in the industrial sector is a key step in achieving low-carbon production systems. Solar systems for industrial process heat and power are gaining attention towards this goal and have the potential for significant scale up, particularly in areas that combine a large and diverse industrial sector with rich solar resources. Therefore, project results are expected to contribute to the following expected outcome:

- Energy efficient solar resource integration in the industrial sector for achieving low-carbon, emission-free production systems.

Scope: Industrial processes need considerable amounts of heat and power. Much of the demand for process heat, roughly 50% among the most energy-intensive manufacturing industries, including food and beverages and pulp and paper, occurs at temperatures of 400 °C or less. The Solar Thermal (ST) medium-temperature process heat or cogeneration with electricity can be an effective way to transition to clean energy sources and displace conventional fossil fuel use in industry. On the other side, Photovoltaic (PV) systems convert sun-light to direct current (DC) electricity and the electricity can be used to power or heat industrial processes directly (or via the grid) with electric heating technologies. The two solar technologies (PV and ST) are not competing but can be suitably integrated in an energy system to best benefit of the different features offered by the two options. This high synergy output would allow a useful integration of solar in many industrial processes.

Proposals are expected to:

- Demonstrate a system that considering solar energy's generation potential, topographic characteristics, land-use constraints and system performance, generates solar medium-temperature heat and electricity in a modular, low environmental footprint, low cost and high-efficiency hybrid PV and ST design. Optimize the manufacturing processes based

on the process integration concept (presenting opportunities for energy efficiency and heat recovery) and process control, to reduce process power and heat demand to its practical minimum for an energy efficient solar energy supply (possibly including storage) investment.

- Demonstrate the potential of hybrid approaches (PV and ST) that produce heat and electricity to power a broad range of manufacturing end uses. A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2023-D3-01-05: Critical technologies for the offshore wind farm of the Future

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 18.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Improved performance of offshore wind turbines and efficient use of the marine space.
- Reinforced European offshore wind turbine value chain, supporting local companies and creating local jobs and skills.

- Reduce the possible impacts of offshore wind turbines on protected species and habitats.
- Reduced use of primary raw materials and reduced dependency on scarce raw materials.
- Reduction of LCOE and increased sustainability.

Scope: The objective is to bring major innovations in the design and manufacturing of large offshore wind farms, aiming at >15 MW for fixed bottom offshore applications and >12 MW for floating offshore installations.

Attention can be paid to substantially reducing the wind turbine mass (rotor/nacelle/tower) as well as on advanced lean marine-compatible substructures, advanced (dynamic) cabling and connectors, including floating platforms and its moorings. Innovations such as compact generators, smart blades, reliable drive trains, can be investigated alongside new turbine designs. Innovative low-cost substructures with suitable geotechnical and hydro-dynamic properties should be developed using long-lasting, anti-fouling, corrosion resistant materials with high damping properties.

The projects should exploit improved understanding of the issues related to materials in the upscaling of wind energy turbines/systems (stresses and strains, delamination, etc.)

The innovations should contribute to sustainability considering circularity in the design phase, less (or no) use of (critical) raw materials and decreasing negative environmental and social impacts. They should also contribute to the mitigation of the possible impacts to protected species and habitats.

Such development will allow further deployment of offshore wind energy conversion systems and dramatically increase the offshore wind potential while reducing public acceptability barriers (noise, visual impact).

The active participation of relevant industrial partners and technology suppliers is essential to form a multisectoral, multidisciplinary consortium able to achieve the full impact of the project.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that describes that further R&I action is needed in critical raw material substitution, reducing the environmental impacts of offshore technologies, and job creation.

HORIZON-CL5-2023-D3-01-06: Demonstration of advanced biofuel technologies for aviation and/or shipping

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 18.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁶¹ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Expand the technology portfolio for ready to pre-commercial plant investments in advanced biofuel technologies for aviation and /or shipping.
- Support de-risking the technology, boost scale-up of advanced biofuels for aviation and /or shipping and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in aviation and /or shipping.
- Support better integration of advanced biofuel technologies in aviation and /or shipping.

Scope: Demonstration of technological pathways for the production of liquid jet-drop-in and/or liquid bunker drop-in advanced biofuels with reduced cost and GHG emissions from biogenic residues and wastes including CO₂ or microalgae (including cyanobacteria) through chemical, biochemical, biological and thermochemical pathways, or a combination of them.

¹⁶¹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

A reduced cost or at least cost parity with existing biofuels for use in aviation and/or shipping is expected, as for example the hydro processed esters and fatty acids (HEFA) for aviation and the biodiesel for shipping. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

GHG reduction from fossil equivalents above the state of the art should be shown.

The sustainability and GHG reduction should be addressed on a life-cycle assessment basis.

HORIZON-CL5-2023-D3-01-07: Demonstration of synthetic renewable fuel for aviation and/or shipping

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 18.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Expand the technology portfolio for ready to pre-commercial plant investments in synthetic renewable fuel technologies for aviation and /or shipping.
- Support de-risking the technology, boost scale-up of synthetic renewable fuel for aviation and /or shipping and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in aviation and /or shipping.

- Support better integration of synthetic renewable fuel technologies in aviation and /or shipping.

Scope: Demonstration of innovative technological pathways for the production of synthetic renewable fuels for aviation and /or shipping from renewable energy, CO₂, and/or renewable carbon, nitrogen, hydrogen or their compounds, as for example renewable synthetic paraffinic kerosene, renewable methanol/methane and renewable ammonia. Pathways via production of renewable hydrogen or renewable hydrogen ionic compounds from all forms and origins of renewable energy (e.g., electricity, direct sunlight, heat) are in scope. Cost reduction compared to current state of the art including via electricity pathways and above state of the art GHG reduction from fossil fuel equivalents are expected to be shown. An assessment for the scalability potential of the technology, as well as for the overall energy efficiency, the GHG emissions and sustainability based on life cycle analysis should be included. Proposals should provide information and assessment about the economic feasibility of the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2023-D3-01-08: Demonstration of sustainable tidal energy farms

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 40.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- De-risking tidal energy technology development and increased bankability/insurability of tidal energy.
- Increased availability and improved market confidence in the technology.
- Increased knowledge on positive and negative impacts of ocean energy on its environment and in the case of negative impacts to protected habitats and species proposals for necessary mitigation measures.
- Publicly available data collected from the demonstration/pilot structure including support structure.

Scope: Demonstration of sustainable tidal energy pilot farms (minimum 4 MW installed capacity and at least 4 devices) in full operational conditions for long periods of time is essential to advance this sector. It is the way to bridge the gap from technology development to market development while reducing costs, reducing risks and attracting investors for future commercial projects. The farm is expected to be composed of several devices of the same series.

The tidal energy farms have to be connected to the electricity grid. To focus on the technologies with the greatest chances of success, the single tidal device to be used in the array deployment is expected to be satisfactorily demonstrated at full scale before, with limited changes to incorporate the learnings. Any change on the tidal device may be incremental but should not involve fundamental changes to the device design or composition.’ The innovation component should mainly lie on the pilot farm systems and supporting industrial manufacturing activities that enable a cost-effective and high-performance pilot farm. The project is expected to deploy a tidal energy farm with a minimum capacity of 4 MW and operate the farm at least 2 years in the lifetime of the project. After the project it is expected that the farm will continue to be operated for at least 8 years.

The project should develop and execute an effective operation and maintenance programme.

Proposals are expected to address also all the following for both the supporting infrastructure for the farm and for the individual devices themselves:

- Industrial design and manufacturing processes, circularity of (critical) raw materials, sustainability, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.
- Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Necessary mitigation measures should be integrated to protect habitats and species. Present an environmental monitoring plan to be implemented during the demonstration action. Environmental monitoring data should be open source and be shared with EMODNET and the IEA OES environmental task.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a

techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project, and if needed a plan to achieve certification by an independent certification body before the end of the action. The project proposal is expected to present a clear and convincing pathway to obtain necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. For this the use of other EU/national/regional support mechanisms can be considered. Independent experts will assess all deliverables and will advise for the go/no-go decision.

The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Data from the pilot structures should be collected to understand the performance and behaviour of the structure and the surrounding environmental condition, to optimise the concept and understand the environmental impact of tidal energy harvesting.

The selected projects are expected to contribute to the BRIDGE initiative¹⁶², actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-09: Waste heat reutilisation from data centres

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

¹⁶² <https://www.h2020-bridge.eu/>

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to the following expected outcome:

- Make sustainable seasonal storage solutions available to data centres to allow year-round optimised operation in urban environments in an integrated way to supply heat to neighbouring district heating system(s), agriculture and/or industry optimising use of excess heating energy and required cooling energy.

Storage solutions with high round-trip efficiency, low dependence on critical raw materials, low land/space footprint will be considered as advantage.

Scope: Two main obstacles arise in relation to the reuse of waste heat from data centres:

- First, data centres produce more waste heat in summer/when it is hot outside. The PUE (Power use effectiveness) of data centres vary considerably along the year, because in winter they can resort to free cooling (using fresh air from the outside), while in summer they need to ventilate more and use heat pumps to cool down the outside air. As a result, an important part of data centres’ waste heat is produced when less people need it (at least for domestic heating purposes).
- Second, the heat produced is of poor quality (low temperatures and often light heat vector), so that even for immediate use it is often not economically viable to use heat pumps to “concentrate” it (increase temperature and, if necessary, communicate it to a heavier vector).

Combining waste heat reuse with heat storage would allow data centres to better valorise their waste heat in winter (under the form of residential heating for instance) while storing this heat during hotter periods. From an economic perspective, the increase of waste heat that can be valorised and sold by the data centre during the appropriate seasons may partially compensate the additional costs of cooling during summer months. Such technologies may subsequently apply to other industries generating important amounts of low temperature – low density heat.

Selected projects will test and further develop seasonal heat storage technologies through an integrated pilot that includes at least the following technologies:

- Heating and cooling exchange system for the data centre and the district heating system.
- Seasonal energy storage.

For efficiency purposes, the storage technology should be able to store the heat for a long time (up to 6 months), with as little energy losses as possible, and using as few compressor steps as

possible. The storage technology should also be non-hazardous and be deployable close to dwelling areas without posing a threat to them. Additionally, a specific consideration should be given to the cyber-physical security of the combined storage and restitution system.

Optionally, the project could involve heat pump manufacturers to explore the benefits of heat pump technologies to the overall heat storage facility.

Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2023-D3-01-10: Supporting the development of a digital twin to improve management, operations and resilience of the EU Electricity System in support to REPowerEU

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increase the reliability of the energy system by enhancing flexibility and efficiency of the European electricity grid to make it ready for the needed drastic increase of the renewable energy share and more resilient to future shocks (such as cyber-attacks) through scenario analysis and modelling.

- Improve management, maintenance and operations of the EU Electricity System.
- Enhance dynamic monitoring of the energy system, to facilitate energy system integration, information flows, detect anomalies, forecasting demand and to address infrastructure bottlenecks.
- Improve the data exchange between TSOs and DSOs and between network operators and the market players, leveraging data exchange from prosumers.
- Creation of new services for companies and public authorities based on the digital twin.

Scope: To deal with the rising complexity of the Energy System(s), and the impact of the fast-changing energy market reality on the energy system, a digital twin of the electricity grid is a key digital solution to support network operators and market players in performing a well-informed decision-making. It is key tool to accelerate the innovation cycle and to reduce the inertia of the energy sector when it comes to the integration of digital solutions in the energy system in order to make it more efficient, resilient and able to integrate higher shares of renewable energies. Digital transformation of the energy system is thus essential to meet the objectives of REPowerEU.

The project is expected to address all of the following:

- Create, develop and test a Digital Twin of the Electricity Grid that covers dynamic monitoring, (smart) grid planning, secure operation, forecasting and scenario analysis.
- It has to be modular, interoperable and implementable at different scales, integrating both (decentralised) supply and demand-side, taking into account all relevant energy data.
- Promote new ways for energy companies, to share data and break the data-silos - simplifying the data maintenance and exchange process - through a dynamic monitoring of the whole system.
- Synchronize data from various systems, including at least 5 TSO, 5 DSO and 5 market parties that are not related in terms of ownership and with varying levels of infrastructure maturity.
- Standardize it into one multi-user platform via standards-based adapters/interfaces, compliant and integrated with the Common European Energy Data Space.
- Use the Digital twin for multi-faceted resilience scenario analysis to investigate how the electricity grid responds to stimuli or shocks (e.g. RES integration, cyber-attacks) and what answers can be provided.
- Test and pilot the applications of science and innovation in the energy sector (e.g. testing the combination of key digital technologies such as High Performance Computing, Big Data, AI, IoT and Cloud Computing) in order to foster the rapid development new services based on them [e.g. Load Balancing, Power Management, Consumer Services,

Demand forecasting real time and interactive computing]. These new services should help to enhance the flexibility and resilience of the EU energy system.

- Involve key organisations to ensure a European approach is required. In particular, ENTSO-E and DSO associations, as well as main stakeholders such as T&D Europe, Eurelectric, SmartEn, etc.

To ensure interoperability and integration into the grid and the federated European digital infrastructure, specific demonstrators will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy and cross-sector systems being developed under ongoing Horizon 2020, Horizon Europe as well as under other EU programs such as the Digital Europe Program and Connecting Europe Facility.

The selected projects are expected to contribute to the BRIDGE initiative¹⁶³, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-11: Demonstration of DC powered data centres, buildings, industries and ports

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 18.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following outcomes:

¹⁶³ <https://www.h2020-bridge.eu/>

- Demonstrated benefits and efficiency of DC power distribution systems compared to AC (no need of AC/DC conversion, less copper, less space occupancy, etc.).
- Increased reliability and resilience of the grid provided by DC power distribution networks.

Scope: Projects are expected to implement the activities in (1), the practical demonstration in (2) and the recommendations in (3) as described below:

1. Development of R&I activities, methodologies and tools for at least two of the sub-topics (A, B, C or D). These can be developed/complemented among them and/or with others pertinent to each sub-topic:

A. DC powered data centre:

- Design and demonstration of a DC powered data centre. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered data centre as well as to supply other DC loads and to collect the energy of DC sources.
- Integration with the UPS systems, innovative generation, sustainable (hybrid) energy storage, etc.
- Renewable energy systems integration.
- Cost Benefit Analysis of the savings compared with the standard AC powered data centre.
- As a supporting reference for data centres, [The EU Code of Conduct Data Centres Energy Efficiency](#) can be used.

B. Application of DC distribution in commercial and residential buildings

- Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered commercial and residential buildings as well as to supply other DC loads and to collect the energy of DC sources.
- Installation of intelligent DC system complete of all the related components (e.g., RES, DC bus, sockets, LED lighting, heat pumps, EV charging stations, sustainable storage systems, etc. The components can be either DC-based or AC-based and appropriately adapted to work within the DC grid.
- Identification of the efficiency of a DC system compared to an AC system in the building sector and the corresponding cost savings.
- Analysis and identification of the main barriers (technical and non-technical) for the development and deployment of MVDC and LVDC systems.

C. Application of DC distribution in industry

- Development and demonstration of DC manufacturing process installation, protection and device technologies. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered industry as well as to supply other DC loads and to collect the energy of DC sources.
- Development of project management tools and methods.
- Demonstration of increased energy efficiency measures such as, for example the use of variable-speed motors, led lighting, storage systems, etc.
- Investigations to enable selectivity between circuit protection devices using different technologies, such as semiconductor breakers, hybrid semiconductor breakers, mechanical breakers and fuses.
- Systems grounding to avoid stray currents and corrosion phenomenon from DC systems such as e.g., rail applications.
- Insulation materials and their applicability for DC loads (investigation on suitability of AC cables for DC, on polarisation effects leading to early degradation and subsequent insulation failure, etc.).

D. Application of DC distribution in ports

- Simulation, analysis, design, develop, test and demonstration of a DC port infrastructure. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered ports as well as to supply other DC loads and to collect the energy of DC sources.
 - Study and development of a tool to estimate the quantity of DC charging infrastructure necessary to support regional adoption of ports' electrification by MS.
 - CBA at system level of a DC compared to an AC supplied port considering all the elements contributing to a real effective analysis on the costs and benefits of the system.
 - Simulation, analysis, design, test and demonstration of all the IT needed for the grid automation.
 - Analysis and definition of possible operating framework and business models for ports acting as energy hubs.
 - Analysis, report and recommendations on the potential of the ports as energy hubs with related planning for its development within the energy transition.
2. Demonstration, test and validation of at least two of the sub-topics developed in (1) (A, B, C or D) in at least two pilots in different EU Member States/Associated Countries.
 3. Identification of standardisation, regulatory barriers and related recommendations.

HORIZON-CL5-2023-D3-01-12: Development of MVDC, HVDC and High-Power Transmission systems and components for a resilient grid

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 22.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁶⁴ .

Expected Outcome: Project results are expected to contribute to at least two of the following outcomes:

- Investigation and development of new converter systems (including back-to-back, floating, new systems with improved compatibility, lower losses, for superconducting technologies applications i.e., medium voltage, high current, etc.) for higher efficiencies.
- Investigation and development of additional sustainable energy storage solutions, interfacing with MVDC, HVDC and/or High-Power Transmission systems, to support

¹⁶⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

the AC system. Storage solutions should aim at high round-trip efficiency, low dependence on critical raw materials, low land/space footprint.

- Investigation and development of DC breaker integrated in Multi-terminal DC (MTDC) systems, including DC breaker for integration with Superconducting cables.
- Investigation and development of the application of DC GIS in VSC MVDC, HVDC converters, including economic benefits on overall system solution.
- Investigation and development of SF6-free technology for new equipment in substations.

Scope: Projects are expected to implement the activities in (1) or in (2) and the corresponding practical demonstration in (3) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to the topic:

- Development of smaller, more compact and/or lower voltage, higher current converter topologies, including floating that can result in significant cost savings offshore.
- Technical analysis of trade-offs in performance, ambient condition impact, maintenance, reliability, dimensioning, testing procedures, etc.
- Demonstration of enhancement of AC system stability and AC system frequency by providing sustainable energy storage systems interfaced to MVDC, HVDC and/or High Power Transmission systems.
- Assessment of technical and economic feasibility of application of DC breakers in MTDC systems.
- Demonstration of DC fault ride through capabilities in MTDC systems by using DC breakers.
- Assessment of potential new converter topologies addressing future offshore developments with the aim of reducing the CAPEX and OPEX of the investments, and with increased fault current capabilities.

2. Boost SF6-free technologies in high and medium voltage equipment, as well as a regulatory roadmap for replacement and new assets (HV: TRL 4-5; MV: TRL 6-8):

- Investigation and development of switchgears using SF6-free technology with low impact on GWP. Alternative SF6 gases with low environmental impact while at the same time ensuring low space occupancy for offshore applications on platforms.
- Assessment of grid resilience and the economic and environmental impact of replacement and new installation rollout options (timeline, perspective of global market, grid reliability and full lifecycle impact).

- Regulatory recommendations at EU level to cope with financial risks inherent with putting novel technologies into the system and transition time options to move from SF6 to SF6-free technology for new equipment.
- Investigation and development of an SF6-free gas-insulated substation or air-insulated SF6-free instrument transformers or switchgear at different voltage levels.

3. Demonstration, test and validation of the activities developed in (1) or in (2) in at least two pilots in different EU Member States/Associated Countries.

The selected projects are expected to contribute to the BRIDGE initiative¹⁶⁵, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-13: Development of novel long-term electricity storage technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following expected outcomes:

¹⁶⁵ <https://www.h2020-bridge.eu/>

- Increased availability, robustness, and safety of sustainable and efficient energy storage solutions to reduce energy losses, increase cost effectiveness and improve the environmental footprint of the energy system.
- Availability and functionality of innovative energy storage systems developed for specific system designs and applications.
- Increase technology leadership, competitiveness, and technology export potential of European storage technology industry.
- Enhanced sustainability of storage technologies, taking fully into account circular economy, social, economic, and environmental aspects in line with the European Green Deal priorities.

Scope: Development of novel storage technologies, going beyond the state of the art, which are providing best-fit in form of CAPEX, OPEX, efficiency and sustainability and are adapted to specific needs of the energy system. Examples for such specific needs are responsiveness to energy system flexibility need, necessary storage amount or specific requirements due to off-grid situations. Focus is on longer-duration technologies, compared to lithium-ion technology, which is currently dominating new storage projects. In scope are novel chemical, mechanical, thermic storage technology solutions, excluding batteries and hydrogen. Innovative storage solutions should show clear innovation with respect to the state of the art e.g. through use of new advanced materials or new design solutions, always bearing in mind the objective of sustainability and circular economy, minimizing the environmental footprint, which should be underpinned by an LCA. The developed solutions should be highly performant in respect of expected future investment and operational costs and business cases in existing or emerging energy markets and go beyond the state-of-the art of existing storage solutions in respect of two or more of the following parameters:

- Sustainability;
- Technical performance, including round-trip efficiency;
- Lifetime;
- Non-dependency on location geographical particularities strategic independence (=no or limited use of CRMs);
- Land (space) footprint and/or cost.

Underlying basic material research is excluded.

Projects should address to the extent appropriate intelligent energy management systems, economic viability studies validated by industry and assessment of large-scale replication potential.

The selected projects are expected to contribute to the BRIDGE initiative¹⁶⁶, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-14: Demonstration of innovative, large-scale, seasonal heat and/or cooling storage technologies for decarbonisation and security of supply

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 30.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased availability, robustness and safety of sustainable and efficient choices for energy storage to increase security of supply, reduce energy losses, cost effectiveness and improve the environmental footprint of the energy system.
- Availability and functionality of innovative large-scale energy storage systems developed for specific system designs and applications.
- Increase technology leadership, competitiveness and technology export potential of European storage technology industry.

¹⁶⁶ <https://www.h2020-bridge.eu/>

- Enhanced sustainability of storage technologies, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- In addition to development of the storage technology as such, it should be made suitable to accumulation of different heat sources, including solar-thermal energy, geothermal energy, industrial waste heat, as well as heat produced using photovoltaics, hybrid solar panels (Photo-Voltaic Thermal Panels) and wind energy technologies.
- Systemic approach, smart integration concepts, including intelligent management together with other energy sources. Efficient techniques/methodology of buffering between demand and supply to be ensured.

Scope: Demonstration of innovative heat and/or cooling storage technologies, going beyond the state of the art, which address long-term energy storage up to cross-seasonal storage. Large-scale solutions are expected to be embedded into

- District-level heating and/or cooling storage.
- and/or integrate heat supply (industry waste heat) and demand for heat for industrial processes.

Where appropriate, contribution to Power-to-Heat-to-Power technology should be explored.

They should optimise CAPEX, OPEX and round-trip efficiency of heat storage, as well as circularity and sustainability of the system and its components, which are expected to be non-toxic, highly durable and reasonably easy to recycle. Land (space) footprint is also an important aspect which should be taken into account. An LCA should be performed. Strategic independence is to be considered, i.e. use of abundant materials whenever it is possible.

The demonstration projects should address the required methodologies for the predictive maintenance and control of the whole system.

Maximum use of all available thermal energy sources as well as systemic approach to integration into energy system is to be ensured.

(Indirect) collaboration with IEA's Energy Storage Technology Collaboration Programme is to be ensured, e.g. through IEA Member States. Notably: Task 39 "Large Thermal Energy Storages for District Heating".

Basic material research is excluded.

Projects should address economic viability studies validated by industry and assessment of large-scale replication potential. The exploitation plans should include business plan indicating the possible funding sources to be potentially used (such as private equity, InvestEU, EU Catalist Partnership and the Innovation Fund).

HORIZON-CL5-2023-D3-01-15: Supporting the green and digital transformation of the energy ecosystem and enhancing its resilience through the development and piloting of AI-IoT Edge-cloud and platform solutions

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 18.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 for digital energy solutions by the end of the project starting from general purpose digital solutions of at least TRL 5-6 – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Major contribution to the implementation of the Digitalisation of Energy Action plan.
- Innovation in data-driven energy services by 3rd parties through fast spreading, market uptake and validation under critical operating conditions in a real environment of transparent, accessible and reliable highly distributed open platforms, frameworks and mechanisms for data exchange and storage to support innovative services (for flexibility, RES integration, etc.) across the EU, based on Open Source developed solutions.
- Validation in a large-scale environment of the application of cutting-edge digital technology (Cloud-Edge continuum, edge intelligence, AI/ML (federated learning), IoT) in a more decentralised environment in the energy sector.
- Full set of relevant commonly agreed digital standards applicable to the energy sector through extension and update of existing standards and new standards filling standardisation gaps.

Scope:

- The action should develop solutions that aim at increasing the integration of renewable energy sources, as well as the local generation and consumption of energy and processing of data by developing and piloting at scale open source, environmentally friendly, easily upgradeable and energy-efficient cloud-edge solutions. The application space should include but is not limited to bi-directional EV charging, smart buildings and homes. Solutions are expected to be based on commonly agreed open standards. To the greatest extent possible, they should be building on the common European cloud-edge infrastructure as well as making use of and contributing to the emerging common European data spaces in the fields of energy and mobility. Further, they should support a more decentralised environment for grid flexibility and energy services, based on digital enablers such as artificial intelligence, swarm computing and IoT.
- Validation should be done at least three pilot sites in at least three Member States/Associated Countries and could include under “financial support to third parties” an open call for additional services using up to 10% of the total budget to attract further users and suppliers, in particular SMEs. The modalities of the open call will be defined by the consortium, based on the concrete needs of the project. The appropriate level of data localisation and processing (cloud, edge, far edge, etc.) should be defined on-the-fly by AI algorithms to optimise latency, energy consumption, security, and other important parameters. The solutions must demonstrate critical operation capability such as low-battery, fault tolerance, and harsh weather conditions to ensure the resilient operation.
- To ensure the interoperability among the solutions and with other European IoT research and innovation efforts in the energy and other sectors and the integration into the grid, the project will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing EU programmes and other relevant initiatives¹⁶⁷. Preferably semantically interoperable interactions, as enabled by the ETSI SAREF ontologies, should be used. The projects will be expected to contribute to the piloting, uptake and further development of relevant standards.
- Solutions should include a credible market uptake plan of developed solutions across the EU, in as diverse types of regions and electricity grids (in terms of climate, size, economic activities), and enable 3rd parties, in particular SMEs, to use the developed solutions as a basis to build their innovative data-driven energy services innovations for energy consumers on top of the developed solution. These solutions should collaborate where relevant with the Testing and Experimentation Facility (TEF) for the energy sector.
- The selected projects are expected to contribute to the BRIDGE initiative¹⁶⁸, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional

¹⁶⁷ For example, Horizon 2020, Horizon Europe, Digital Europe Program and Connecting Europe Facility, the Data Space design principles of Open DEI, the project supported under the Interoperability Community CSA and aligned with the Digital Europe Data Centre Support Centre, etc.

¹⁶⁸ <https://www.h2020-bridge.eu/>

contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-16: Support action to the SET Plan IWG on HVDC & DC Technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 0.60 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 0.60 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results are expected to contribute to all the following outcomes:

- Organisational, logistic and secretarial support provided to the SET Plan Implementation Working Group on HVDC.
- Smooth implementation through supporting the actions of the SET Plan for HVDC and DC Technologies in the coming years for the offshore as well as onshore grid development.

Scope: The Implementation Working Group (IWG) on HVDC was set up in 2021 to address specifically the grid development needs deriving from a renewable-based energy system, as called by the Green Deal. With the perspective of the installation of 60 GW of offshore wind and at least 1 GW of ocean energy by 2030 (300 GW and 40 GW by 2050), the Offshore Renewable Energy Strategy has been the triggering event for the creation of the WG. The activities of the IWG range from the support to the development of DC Technologies and Systems to the fostering of the collaboration and coordination within the SET Plan countries to ensure their active involvement.

The support action is intended to facilitate the work of the IWG by providing support to the Implementation Plan on HVDC with activities focusing on:

- Organisational support to the Implementation Working Group on HVDC.
- Coordination with other initiatives/projects and links with stakeholder's fora.
- Dissemination and networking activities with other existing ETIPs and IWGs (e.g., joint workshops, thematic conferences, webinar series, regular exchanges, etc.).
- Development and implementation of robust outreach approaches and societal engagement actions to span across the EU and Associated Countries.
- Organisation and management of documents and files with feed-in of relevant outputs of this CSA into the SET Plan information system (SETIS).

Carbon Capture, Utilization and Storage (CCUS)

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-17: Development of CO2 transport and storage demo projects

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 40.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: The demo project is expected to use the CO2 from one or more capture sites and build or use a transport infrastructure, incl. shipping if needed, to the selected storage site where the CO2 will be injected. Practical experience with a demo project of that kind will increase the knowledge of the full CCS value chain including risk mitigation (financial, technical, and regulatory) taking into account the experience and results from previous research projects. Beside others this might include

for CO₂ transport:

- impact of CO₂ origin, composition and impurities
- safety assessments and engineering design tools
- transport of CO₂ interoperability, including ships
- reuse of pipelines, wells and platforms
- hubs and clusters and concepts
- environmental impacts and risks
- CO₂ flow assurance

for CO₂ storage:

- preparation of storage sites (depleted oil and gas reservoirs, saline aquifers, basalt rocks)
- develop experience with site conformance monitoring and assessment
- storage optimisation through development of a range of injection strategies
- improve understanding of induced seismicity
- prediction of plume under geophysical and geological uncertainty
- flexibility of CO₂ injection ramp up
- environmental impacts and risks, including in the long term

The demo project is expected to be the basis and orientation for future full-size projects.

Scope: The development of regional CCUS clusters and their connection to European CO₂ transport and storage infrastructures that enables cross-border cooperation across regions is crucial for reaching net-zero GHG emissions by 2050. The CCUS technology is not sufficiently operational in Europe yet. To overcome the remaining challenges, further R&I of CO₂ transport and storage demo projects is needed.

Proposals will aim at the development of new demonstration projects connecting CO₂ sources with potential storage sites. Proposals are expected to include a sound assessment of their environmental challenges and risks and feasibility studies focusing on the possible synergies between related projects.

CCUS is an integrated chain of technologies, comprising capture, transportation and/or use and geological storage of CO₂. The next step in the application of CCUS is the development and deployment of CO₂ transport and storage demo projects which show the practical feasibility of the required technologies. This is important to achieve greater efficiency in the transportation of CO₂, notably collecting the emissions from hubs and clusters of industrial

facilities and transporting the collective CO₂ in shared open-access transportation infrastructure to a storage location. Under this approach, costs, risks and necessary support mechanisms can be better evaluated across the CCS value chain, as industrial installations, gas infrastructure companies and storage providers and operators will have clearly defined roles and responsibilities for delivering their tasks and will be compensated for collecting, transport and storage services. The benefits of the shared approach to the transport and storage infrastructure are expected to be evaluated with regard to economies of scale and possibly driving down unit costs for the CCUS value chain. The proposal should address possible barriers for deployment of technical or regulatory nature.

The key options for CO₂ transportation are pipeline transport using new or repurposed infrastructure incl. shipping or other transport modes. The expected demo projects should

- assess the repurposing of existing pipeline networks and/or the creation of new CO₂ transport infrastructure,
- identify and evaluate the benefits and costs (including economic, environmental, social),
- identify barriers to developing such an infrastructure and what action would be required to overcome these.

A successful CO₂ transport and storage demo project might require a European transport and storage network with cross-border connections as not all countries have sufficient storage capacity for their CO₂ emissions.

The selection of the storage site for the project is expected to be based on a detailed assessment. This should include a geological characterisation, including faults and fracture systems; analysis of initial stress field and geo-mechanical behaviour of the storage formations and seals under varying stress and pore-pressure conditions; estimation of storage capacity; accurate modelling of injectivity; overall storage risk assessment, including induced seismicity and blow-out or blockage during injection, and including proposed mitigation action. The assessment should include site-specific solutions for CO₂ injection strategies, pressure management, mitigation of induced seismicity, and MMV (measurement, monitoring and verification).

For CO₂ transport and geological storage, in particular onshore, public acceptability is paramount. Therefore, projects are expected to identify and engage relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) in deliberative activities, so as to analyse their concerns and needs using appropriate techniques and methods from the social sciences and humanities. This should include attention to, significant differences in potential regional consequences where the CO₂ stored comes from power versus industry. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities.

Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects are strongly encouraged to join the EU CCUS knowledge sharing project network.

HORIZON-CL5-2023-D3-01-18: Clean Energy Transition Co-funded Partnership

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 71.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 71.00 million.
<i>Type of Action</i>	Programme Co-fund Action
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The proposal must be submitted by the coordinator of the consortium funded under HORIZON-CL5-2021-D3-01-04 Clean Energy Transition. This eligibility condition is without prejudice to the possibility to include additional partners.</p>
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>The evaluation committee can be composed partially by representatives of EU institutions.</p> <p>If the outcome of amendment preparations is an award decision, the coordinator of the consortium funded under the topic HORIZON-CL5-2021-D3-01-04 will be invited to submit an amendment to the grant agreement, on behalf of the beneficiaries.</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>This action is intended to be implemented in the form of an amendment of the grant agreement concluded pursuant to topic HORIZON-CL5-2021-D3-01-04.</p>

	<p>For the additional activities covered by this action:</p> <ul style="list-style-type: none"> • The funding rate is up to 30 % of the eligible costs. • Beneficiaries may provide financial support to third parties (FSTP). The support to third parties can only be provided in the form of grants. • Financial support provided by the participants to third parties is one of the primary activities of this action to allow the partnership to achieve its objectives. Therefore, the EUR 60 000 threshold provided for in Article 204 (a) of the Financial Regulation No 2018/1046 does not apply. • The maximum amount of FSTP to be granted to an individual third party is EUR 5.000.000. This amount is justified since provision of FSTP is the primary activity of this action and it is based on the extensive experience under predecessors of this partnership. <p>The starting date of the grant awarded under this topic may be as of the submission date of the application. Applicants must justify the need for a retroactive starting date in their application. Costs incurred from the starting date of the action may be considered eligible and will be reflected in the entry into force date of the amendment to the grant agreement.</p>
<p><i>Total indicative budget</i></p>	<p>The total indicative budget for the co-funded European Partnership is EUR 210 million for the period 2021-2027.</p>

Expected Outcome: This topic is for the continuation of the Clean Energy Transition Co-fund partnership (CET Partnership), i.e. EU contribution in WP 2023-2024.

The second instalment of the partnership is expected to contribute to expected outcomes specified in topic HORIZON-CL5-2021-D3-01-04: Clean Energy Transition, for continuation and new development of activities.

The partnership is expected to contribute to all of the following expected outcomes:

- Increased directionality of clean energy transition research and innovation in Europe in line with the SET Plan by a shared pan-European vision regarding the goal and direction of the required system transformation processes adapted to regional needs and availability of renewable energy resources.
- Evidence based energy and climate policy formulation.

- A wider systemic transition and energy supply required for the climate transition in all sectors of society; enabling the transition of the built environment, transport, industry and other sectors to clean, low carbon energy.
- An innovation ecosystem for Europe's transition to clean energy and contribute to a resource-efficient energy system, both from an ecological and economic standpoint.
- A building block to a zero-emission energy system for the decarbonisation of transport, buildings, industry, agriculture in the specific European environment.
- Increased engagement of consumers and prosumers and in appropriate demand-response mechanisms and its integration in the energy system.
- And finally, an energy system that meets the needs of different parts of society, in different geographical locations (urban and rural) and different groups.

Scope: The Clean Energy Transition co-funded Partnership (CET Partnership) is a transnational initiative on joint R&I programming to boost and accelerate the energy transition, building upon regional and national R&I funding programmes.

It aims at empowering the energy transition and contribute to the EU's goal of becoming the first climate-neutral continent by 2050, by pooling national and regional R&I funding for a broad variety of technologies and system solutions required to make the transition. It will foster transnational innovation ecosystems from the very local and regional level, up to the transnational European level, thus overcoming a fragmented European landscape. The CET Partnership enables national and regional R&I programme owners and managers from Member States and Associated Countries to align their priorities and implement annual joint calls from 2022 to 2027. They also organise joint accompanying activities to enable a dynamic learning process, extract strategic knowledge and maximise the impact to accelerate the upscaling, replication and market diffusion of innovative solutions. This will foster the up-take of cost-effective clean energy technologies.

The common vision of the CET Partnership is already manifested in its Strategic Research and Innovation Agenda (SRIA) that has been co-created with the involved countries, the EU SET Plan Implementation Working Groups and ETIPs, all energy relevant ERA-Nets as well as the EERA joint programmes (over 500 editors, co-authors, commenters and discussants). The SRIA articulates the common goal of (1) building a transnational transformative Joint Programming Platform, (2) developing and demonstrating technology and solutions for the transition of energy systems, and finally (3) building innovation ecosystems that support capacity building at all levels.

The objective of this action is to continue to provide support to the European Clean Energy Transition Co-fund Partnership identified in the Horizon Europe Strategic Plan 2021-2024 and first implemented under the topic HORIZON-CL5-2021-D3-01-04, and in particular to fund additional activities (which may also be undertaken by additional partners) in view of its

intended scope and duration, and in accordance with Article 24(2) of the Horizon Europe Regulation.

The consortium which applied to and received funding under HORIZON-CL5-2021-D3-01-04 is uniquely placed to submit a proposal to continue the envisioned partnership. Not only did this consortium submit the proposal leading to the identification of the partnership in the Horizon Europe strategic planning 2021-2024, it has also implemented the partnership through a co-funded call in 2022 and a second call is planned for 2023 in line with the HORIZON-CL5-2021-D3-01-04 Clean Energy Transition topic. It is also relevant that the same consortium was responsible for carrying out related co-fund actions in the field of clean energy under the Horizon 2020 predecessor programme. In this context, the current consortium has particular expertise in relation to the objectives of the Partnership, to the activities to be implemented, and to other relevant aspects of the co-fund action. In practice, another consortium could not continue the activities of the Partnership underway without significant disruption to the ongoing activities, if at all.

The new geopolitical and energy market realities require to drastically accelerate the clean energy transition and increase energy independence from unreliable suppliers and volatile fossil fuels. In support to the objectives of REPowerEU¹⁶⁹ it is expected that the partnership explores pathways and develop new actions to reinforce R&I investments accelerating the clean energy transition and to reinforce the utilisation of R&I results.

It is expected that the European Clean Energy Transition Co-fund Partnership considers also to reinforce the ambition of the planned 2023 joint call and will continue the implementation of its SRIA by setting up joint calls in 2024 and 2025. The partnership can consider to set-up also joint calls without co-funding of from the Union.

Taking into account that the present action is a continuation of the topic HORIZON-CL5-2021-D3-01-04 and foresees an amendment to an existing grant agreement, the proposal should also present in a separate document the additional activities (which may include additional partners) to be covered by the award in terms of how they would be reflected in the grant agreement.

While the award of a grant to continue the Partnership in accordance with this call should be based on a proposal submitted by the coordinator of the consortium funded under the topic HORIZON-CL5-2021-D3-01-04 and the additional activities (which may include additional partners) to be funded by the grant should be subject to an evaluation, this evaluation should take into account the existing context and the scope of the initial evaluation as relevant, and related obligations enshrined in the grant agreement.

The Commission envisages to include new actions in its future work programmes to provide continued support to the partnership for the duration of Horizon Europe.

¹⁶⁹ [REPowerEU: affordable, secure and sustainable energy for Europe | European Commission \(europa.eu\)](https://european-council.europa.eu/media/en/press-communications/infographic/infographic_repower_eu_169.pdf)

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-02

Conditions for the Call

Indicative budget(s)¹⁷⁰

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁷¹	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D3-02-01	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-02	RIA	5.00	Around 2.50	2
HORIZON-CL5-2023-D3-02-03	IA	6.00	Around 3.00	2
HORIZON-CL5-2023-D3-02-04	RIA	6.00	Around 2.00	3
HORIZON-CL5-2023-D3-02-05	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-06	IA	15.00	Around 5.00	3
HORIZON-CL5-2023-D3-02-07	RIA	12.00	Around 4.00	3
HORIZON-CL5-2023-D3-02-08	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-09	IA	8.00	Around 8.00	1
HORIZON-CL5-2023-D3-02-10	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-11	RIA	9.00	Around 3.00	3
HORIZON-CL5-2023-D3-02-12	IA	14.00	Around 7.00	2

¹⁷⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹⁷¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL5-2023-D3-02-13	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D3-02-14	RIA	12.00	Around 6.00	2
HORIZON-CL5-2023-D3-02-15	RIA	12.00	Around 4.00	3
HORIZON-CL5-2023-D3-02-16	IA	20.00	Around 5.00	4
Overall indicative budget		161.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-02-01: Development of near zero-emission biomass heat and/or CHP including carbon capture

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Advance the European scientific basis and increase technology competitiveness and technology export potential in the area of bioenergy.
- Reduced cost and improved technical performance and efficiency of bio-based heat and/or CHP.
- Enhance sustainability of biomass-based heat and/or CHP by addressing socioeconomic and environmental sustainability, in particular in reducing emissions and air pollution and also addressing aspects of carbon reuse and circularity, also in particular in fossil-fuel-based economic areas in transition.

Scope: Development of novel near zero-emission bio-based heat and/or CHP technologies, which allow for highly efficient use of sustainable solid biomass residues, going hand in hand with close to zero emissions for particles and harmful gaseous emissions including NO_x, SO_x, aromatics etc. Flexibility for different biomass fuels and power/heat ratios featuring a wide range of temperatures for heat supply as well as technological interfaces for carbon capture as well as high cost-efficiency for the consumer are to be included.

The near zero-emission solution has to be implemented and assessed for the running biomass-based heat and/or CHP system at pilot scale. Cost performance and environmental impact should be assessed and improved in comparison to state-of-the-art emissions capture and cleaning systems.

Socio-economic aspects including SDGs when applying such solutions in regions in transition from coal, lignite, peat, or other fossil fuels should be analysed and illustrated in the proposal.

HORIZON-CL5-2023-D3-02-02: Novel thermal energy storage for CSP

Specific conditions

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<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Improved dispatchability of concentrated solar power (CSP) plants.
- Improved role of CSP plants in the energy system.
- Reduced greenhouse gas emissions.
- Achievement of the CSP targets of the Strategic Energy Technology Plan.

Scope: Support will be given to novel thermal energy storage solutions for CSP plants. The thermal energy storage solutions proposed will have to be more efficient, cost effective and reliable than current commercial solutions and achieve similar performance in terms of cycles.

The applicants should convincingly present that the storage solution that is developed has the potential to be applied at commercial level.

Projects should consider the possible impact on human health and assess the sustainability of the proposed solutions in environmental and socio-economic terms, taking into consideration the global value chains. Applicants are encouraged to consider a ‘circularity by design’ approach.

HORIZON-CL5-2023-D3-02-03: Industrial manufacturing for lower-cost solar thermal components and systems

Specific conditions	
<i>Expected EU</i>	The Commission estimates that an EU contribution of around EUR 3.00

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<i>contribution per project</i>	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduced greenhouse gas emissions.
- Reduced consumption of materials.
- Reduced environmental footprint of the European solar thermal manufacturing industry.
- Increased competitiveness of the European solar thermal manufacturing industry.

Scope: Support will be given to innovative solutions to manufacture components and/or sub-systems and/or systems for solar thermal applications. The manufacturing solutions should increase the production output and reduce the cost vis-à-vis current production lines. The solutions should integrate quality controls and be flexible enough to adapt to various solar thermal applications.

The proposal should assess and optimize the requirements in terms of materials needed to produce the components and/or sub-systems and/or systems.

Applicants are encouraged to consider a ‘circularity by design’ approach.

The plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan), indicating the possible funding sources to be used (in particular, the Innovation Fund).

HORIZON-CL5-2023-D3-02-04: Innovative components and configurations for heat pumps

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to some of the following expected outcomes:

- Improved performance of heat pumps and/or heat pump components.
- Reduced environmental footprint of heat pumps and/or heat pump components.
- Reduced greenhouse gas emissions.
- Enhanced energy system integration.

Scope: Support will be given to develop innovative heat pumps and/or heat pump components. The innovative heat pumps and/or heat pump components should be more efficient and more reliable than current commercial solutions. They should be safe and affordable.

The proposal should assess and optimize the requirements in terms of materials needed to produce the heat pumps and/or heat pump components.

Applicants should apply a ‘circularity by design’ approach and assess the sustainability of the proposed solutions from a life cycle perspective. Among others, they should estimate the carbon footprint expressed in gCO_{2e}/kWh of heat and/or cold delivered.

The requirements of the final users and/or installers should be properly assessed (e.g., in terms of 'plug-and-play' installation, day-to-day operation, maintenance, space requirements, noise, integration with networks and/or other devices, demand response capability, etc.).

Proposals investigating heat pumps with a capacity >12 kW are expected to use refrigerants with 100-year Global Warming Potential (GWP) < 150 (timeframe based on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)).

Proposals should consider standardisation activities as part of their R&I approach, with a view to bringing their technologies closer to the market.

HORIZON-CL5-2023-D3-02-05: Advanced exploration technologies for geothermal resources in a wide range of geological settings

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduction of LCOE approaching SET Plan targets.
- Improved exploration technologies leading to increased drilling success rate and performance and reliability improvement of shallow and/or deep geothermal systems.
- Increased knowledge to reduce risk of seismicity and to reduce environmental impact in line with the DNSH principle.
- Increased region, city, and citizen engagement for geothermal energy.

Scope: To ensure a reliable pre-drilling assessment of shallow and/or deep geothermal resources and reservoirs, high resolution reservoir characterisation and exploration methods and approaches are essential to minimize exploration and production risks.

The projects will have to include:

1. The development and application of new tools and techniques for a wider range of geologically complex geothermal resources/reservoirs and
2. Coupled with innovative modelling and simulation techniques, increasing measurement precision and applying faster analysis of acquired data to achieve a feasible model of the reservoirs, and fracture systems and
3. The update and improvement of state-of-the-art geological reservoir characterisation and exploration techniques and methods to reduce the average cost for exploration. Such progress will be addressed in increasing detail the geological complexity of resources and increasing target depths.

Technical and economic validation is expected of the innovative exploration and production approaches and tools and methods which are expected to increase the precision for geologically based resource assessment, the target definition of exploratory drilling, and to improve the characterisation and prediction of reservoir geology and long-term reservoir performance. Moving beyond the state of the art by demonstrating the application of new tools, developing new approaches and taking advantage of improved software and computing power, the drilling success will be increased by 20% in 2030 and 50% in 2035 thereby reducing the exploration costs.

HORIZON-CL5-2023-D3-02-06: Smart use of geothermal electricity and heating and cooling in the energy system

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.
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Expected Outcome: Geothermal as backbone of a heating grid including geological thermal storage facilities as system support. Project results are expected to contribute to all of the following expected outcomes:

- Geothermal energy will be widely deployed and competitively priced, underpinned with reduced capital, operational and maintenance costs. Geothermal and geological thermal storage facilities as support system will be a backbone of the heating grid .
- Improved system integration of geothermal heat and power plants coping with changing demand for electricity, heat and cooling and intermittent renewable power generation.
- Enhanced operation flexibility of a geothermal heat and power plant by improving substantially key performance indicators: ramp rate & start-up time, power & heat operation range, overload capability.
- Implementation of smart control system aiming at optimizing plant operation by taking into account various control parameters (current and anticipated) such as demand (power & heat), price signals, flexibility of demand, ancillary grid services, renewable generation, etc.

Scope: Projects are expected to:

- Demonstrate the technical and economic feasibility of responding to commands from a grid or network operator, at any time, to increase or decrease output ramp up and down. - demonstrate the automatic generation control (load following / ride-through capabilities to grid specifications) and ancillary services of geothermal power plants Address flexible heating and/or cooling supplied from binary cycles or EGS plants, including coupling with renewable energy sources.
- Increase variable demand of heating, cooling and electricity by integration of adequate installations and equipment such as heat pumps, energy piles, energy sheet pile walls, ORC turbo-expanders, heat exchanger networks, hot and cold reservoirs (e.g. geothermal storage, UTES).

Actions are expected to consider the development of transmission and distribution infrastructure, and the interplay with other flexibility options (e.g. demand-side management and storage), and test on dispatchability leading to AI-based smart thermal grids balancing generation and demand. The flexible generation should be able to provide additional services to the grid such as inertial services/peak power, role in electricity balancing/reserve market. Projects should integrate increased diagnostics on components for performance/reliability monitoring (maintaining high level of heat transfer – durability, fouling issues...).

Plans for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2023-D3-02-07: Development of next generation advanced biofuel technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increase availability of disruptive emerging advanced biofuel technologies.
- Accelerate the readiness of cost-effective and highly performing future technologies of advanced biofuels for all economy sectors.
- Reinforce the European scientific basis and European technology export potential for advanced biofuel technologies.

Scope: Development of next generation technologies for the production of novel advanced liquid and gaseous biofuels from biogenic residues and wastes including CO₂ and organic part of wastewater or micro-algae (including cyanobacteria), through chemical, electrochemical, biochemical, biological and thermochemical pathways, or a combination of them. Focus should be on the high conversion efficiency and the low to near-zero carbon emissions from the overall production. Overall, proposals are expected to improve competitiveness and minimize GHG emissions through synergies with renewable hydrogen

and other renewable energy technologies for processing energy. The new technologies should also address specifically uses in fuel cells for all transport modes for electricity generation from biofuels used as renewable energy carriers with high conversion efficiency and low pollution. The sustainability and GHG emissions should be assessed by an LCA and ways along the value chain to reduce them to and below net zero should be developed.

HORIZON-CL5-2023-D3-02-08: Development of microalgae and/or direct solar fuel production and purification technologies for advanced aviation and /or shipping fuels

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least 3 of the following expected outcomes:

- Availability of disruptive sustainable renewable fuel technologies in order to accelerate the replacement of fossil-based energy technologies in aviation and/or shipping.
- Reduced cost and improved efficiency of sustainable microalgae-based and/or direct solar renewable fuel technologies and their value chains.
- Increase technology leadership, competitiveness and technology export potential of European industry in possibly game-changing microalgae and/or direct solar renewable fuel technologies.
- Enhanced sustainability of aviation and/or shipping fuels, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).
- Increasing the European energy security and reliability by enlarging the renewable feedstock basis for aviation and maritime fuels as well as maintaining and fostering the European global leadership in affordable, secure and sustainable microalgae-based and/or direct solar fuel renewable energy technologies.

Scope: Development of microalgae and/or direct solar fuel production and purification technologies for making advanced aviation and /or shipping fuels from microalgae and/or direct sun use a techno-economic feasible, cost-effective and sustainable option for large-scale use of microalgae-based and/or solar-based advanced fuels in aviation and /or shipping. Specific focus should be on purification of microalgae biomass and /or direct solar fuel components and delivery to advanced algae-based fuels and /or direct solar fuels for aviation and/or shipping. Acknowledging problems of culture or system contamination and the specific challenge of energy-efficient product purification, the specific techno-economic challenges of microalgae and/or direct solar fuels for renewable fuel production should be addressed with novel and innovative technologies, by taking in particular into account effects on CAPEX, OPEX, energy efficiency, GHG balance and circularity of materials and process streams. Proposals should also address systemic constraints and opportunities for scaling-up algae-based and/or solar fuel technologies.

Direct solar fuels are in this context renewable synthetic fuels made by direct conversion routes from solar to chemical energy. Photovoltaic systems with separate fuel production and hydrogen as a fuel end-product is excluded.

The sustainability and GHG reduction should be addressed on a life-cycle assessment basis including circular economy, social, economic and environmental aspects.

Projects are expected where possible to collaborate with and contribute to the activities of the Coordination and Support Action funded under the topic HORIZON-CL4-2021-RESILIENCE-01-16

HORIZON-CL5-2023-D3-02-09: Demonstration of sustainable hydropower refurbishment

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.

<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁷² .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Refurbish, upgrade and increase existing hydropower capacity to make it fit for market and digital challenges of the future power system and for supporting increasing shares of variable renewable energy sources.
- Increase technology leadership, competitiveness and technology export potential of European hydropower industry.
- Enhanced sustainability of refurbished hydropower installations, taking fully into account circular economy, social, economic and environmental (including climate change) aspects in line with the European Green Deal priorities and in particular biodiversity.

Scope: Demonstration of innovative solutions for sustainable hydropower refurbishment. With existing hydropower installation as a base, solutions are expected to demonstrate innovative technical solutions for refurbishment with increased sustainability of refurbished hydropower in terms of business models in changing power markets, including digital requirements. In this context, the overall future potential of the innovative solutions in EU Member States/Associated countries should be analysed. It is required to improve

¹⁷² This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

environmental sustainability with a particular focus on biodiversity including up- and downstream -migration of aquatic organisms and sediment management and maintaining important geomorphological processes and preserving habitats. Also, additional benefits for society should be addressed, e.g. for recreational use, flood control, navigation, drought management. The innovative refurbishment solution should go beyond increased efficiency but lead to net-improvements in socioeconomic and environmental sustainability also considering future climate change adaptation needs. Socio-economic and environmental sustainability including SDGs, circular economy, social, economic and environmental aspects should be addressed on a life cycle basis.

HORIZON-CL5-2023-D3-02-10: Development of innovative power take-off and control systems for wave energy devices

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁷³ .

¹⁷³ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Demonstrated increased performance and reliability of wave energy devices.
- Improved knowledge on how to operate wave energy devices, their availability, maintainability and survivability.
- Reduction of LCOE.
- Reinforced industrial supply chain in Europe.

Scope: Power take-off (PTO) and control systems (including "prime mover" (waves to mechanical power) as well as the ancillary equipment like gearboxes, generators, and power electronics, power controllers, grid interfaces and other items) are key subsystems of wave energy converters. PTO and control systems can be improved to increase the efficiency of the whole converter, to increase reliability by controlling for instance the structuring health and power electronics, and to avoid extreme events that might compromise device survivability. Control systems dynamically adapt to and mitigate the forces of the continually changing ocean conditions. This can prevent damage during extreme events, contribute to increased performance and the viability of the technology. The manufacturing and testing of prototypes are relatively costly, and it is imperative that data from the demonstration are available to avoid repeating early engineering mistakes. Validation of the innovative concepts is expected to be done in realistic environments at small scale for longer periods or by onshore testing and controlled lab testing. If validation is done onshore the project should demonstrate that they can make use of existing test rigs or develop a test rig for the project, which can be used after the project by other developers. Development and demonstration of the PTO technology should be combined with control strategies as their requirements are inherently coupled. In the validation it is expected that key performance indicators are used based on international recognized metrics

In the development of the PTO system the ‘circularity by design’ principle should be used.

HORIZON-CL5-2023-D3-02-11: Advanced concepts for crystalline Silicon technology

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility</i>	The conditions are described in General Annex B. The following

<i>conditions</i>	<p>exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Technology Readiness Level</i>	<p>Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.</p>

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements.

Consequently, project results are expected to contribute to all of the following outcomes:

- PV modules with higher efficiencies and lower costs, paving the way for mass production.
- Lower environmental impact with efficient and optimised use of materials/resources.

Scope: Wafer-based crystalline silicon (c-Si) PV technology is dominating the PV market, sharing its 95%, with a significant historical module price reduction trend. The driving force for such PV cost reduction is undoubtedly attributed to the advancement in cell and module performance in the last few decades, in addition to economies of scale. Improving cell and module efficiency will continue to play a significant role in lowering the levelized cost of electricity (LCOE), by saving the cost of land and balance of systems while producing the same amount of electricity.

Proposals are expected to develop architectures approaching the theoretical efficiency limit of c-Si cells and providing the direction for even higher mass-production industrial cell performance (for example by reducing surface recombination in silicon, lowering recombination losses at metal contacts, maximizing light trapping in silicon, etc.), with:

1. Nanophotonic structures to maximize absorption and minimise reflection, enabling reduced silicon consumption and higher efficiencies.
2. Innovative texturisation and light-trapping concepts for thin and ultrathin c-Si solar cells.
3. Advanced low-cost surface passivation and novel passivating contacts; novel heterojunctions.
4. Low-cost and Ag-free metallisation, TCOs using abundant materials (In-free), such as AZO.
5. Direct bandgap architectures for very high efficiencies and/or thinner cells.

HORIZON-CL5-2023-D3-02-12: Large Area Perovskite solar cells and modules

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements.

Consequently, project results are expected to contribute to all of the following outcomes:

- Increase the lifetime, efficiency and minimise the environmental impact of Perovskite PV.
- Enlarge with novel perovskite device architectures the integration and application possibilities of PV technology.
- Increase the potential for industrial production and commercialisation of perovskite PV creating a competitive technological know-how for the European PV industrial base.

Scope: The record power conversion efficiency of small-area perovskite solar cells has impressively exceeded 25%. For commercial application, scaling up the device area to fabricate efficient perovskite solar modules is the necessary next step. However, there is still a certain efficiency gap between the large and small size. To minimise this gap proposals are expected to:

- Demonstrate an industrially scalable method for the (homogeneous) deposition of high-quality large-area perovskite films.
- Demonstrate fabrication of large-area charge transporting layers and electrodes.

In addition to improving the efficiency for commercial development of Perovskite PV, lifetime is another challenge that urgently needs to be addressed also in tandem architectures.

- Identify and tackle complex stability issues at the device and module level (related to the processes involved in the fabrication).
- Develop updated test protocols and perform outdoor field performance testing of the perovskite modules.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2023-D3-02-13: Operation, Performance and Maintenance of PV Systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

	additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. Its current contribution to global electricity demand is around 5% and is rapidly growing. PV already represents a share of more than 8% of the electricity generation in some EU Member States/Associated countries while penetration levels are expected to reach soon double-digit in Europe. It is within this scenario that the PV sector will ensure that the installed power capacity in GW can also reliably generate TWh of electricity for an extended lifetime.

Therefore, project results are expected to contribute to all of the following expected outcomes:

- Increase PV system performance, reliability, security and flexibility under various topology and operating conditions with enhanced digitalisation
- Increase utility-friendly integration of PV generation into the European energy system at high-penetration levels and the profitability of PV systems

Scope: Proposals are expected to demonstrate technical solutions, processes and models, which increase a PV system's operational performance, stability and reliability. The introduction of novel PV technologies and novel PV system designs makes the need of increased field performance and reliability a continuous industry demand.

More specifically, proposals are expected to:

- Demonstrate integrated multi-aspect sensing (optical, thermal, electrical) into PV modules to suppress degradation, detect unwanted operating conditions and avoid failures with emphasis on achieving high MWh/Wp (e.g. shade tolerant; more advanced electronic design with in-module components).
- Demonstrate smart control/tracking systems (e.g. coupled with real-time monitoring data, forecasting, EMS, etc.) for performance optimisation in specific PV applications (e.g. “self-protection” under extreme events in harsh environments like dust/snow storms).
- Demonstrate hybrid or integrated monitoring-diagnostic imagery solutions for maximum spatiotemporal granularity and diagnostic resolution. Multispectral imagery inspections linked with electrical signature, synchronisation of field techniques with monitoring.
- Apply edge AI and Big Data to improve the energy yield (advanced module control, self-reconfigurable topologies, etc.), module and plant models, monitoring and yield forecasting considering user behaviour and modelling of the entire electricity system including storage.

- Build large (time and scale-wise), wide (including not only yield but multisensory operational, thermal, mechanical and environmental data) and possibly publicly available datasets to enable, foster and empower AI for Digital PV at European scale.
- Demonstrate automated and predictive PV asset management software based on sensor-data-image fusion and/or AI / Machine learning techniques to reduce human effort and increase trustworthiness of current PV asset management software.
- Enable AI-based energy trading at plant level, taking care of specific climates /applications / conditions (snow, dust, environmental pollution, water...)/user behaviours.

HORIZON-CL5-2023-D3-02-14: Digital twin for forecasting of power production to wind energy demand

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁷⁴ .

¹⁷⁴ This [decision](#) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link:

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Accurate and precise energy yield prediction to ease investment decisions based on accurate simulations that take into account simultaneously predictions on Renewable Energy Production, Energy Consumption and Price Predictions.
- Enhanced digital transformation of wind energy sector by delivering the next generation of digital twins.

Scope: The expected growth of both on- and offshore wind energy is enormous and many new wind parks are planned for the coming years. Experience from the existing wind farms shows the importance of a proper micro-siting of the wind turbines as well as their efficient interconnection within the farm. In addition, bringing wind farms together into clusters toward a wind power plant concept might induce long distance negative interaction between the farms, reducing their expected efficiency. This might happen both on- and offshore. The high amount of connected wind power and the expected increase during the coming years, requires that this technology has to be prepared to take a more important role as of its contribution to the reliability and security of the electricity system. The objective of this topic is to develop new digital twins to optimise the exploitation of individual wind farms (onshore, bottom-fixed offshore and floating offshore) as well as wind farm clusters, in view of transforming them into virtual power plants delivering a more reliable and secure electricity system. Such a digital twin is expected to integrate [at least three of the following bullet points]:

1. Wind and weather forecast models relevant for the full wind power production system (turbines, grid, transmission) (including the effects of external physical conditions such as temperatures, rain, turbulences, waves, and currents).
2. Spatial modelling: medium (within wind farms) to long distance (between/along wind farm clusters) wake effects.
3. Interconnection optimisation via simulations to satisfy grid connection requirements and agility in grid reconfiguration and provide ancillary services.
4. Include predictive maintenance, structural health and conditional monitoring, and
5. End user location and needs.

The digital twin will improve accurate energy yield prediction and will balance supply and demand side needs and will help to ease investment decisions based on accurate simulations. The models should incorporate other relevant parameters influencing the siting of wind farms, such as ground conditions, noise impacts and environmental impacts as well as representing the complex system in a map view format while considering time series data of each and

every asset. Infrastructure modelling of each and every asset should be executed via independent profiling based on past performance data and contextual data in view to deliver prediction at the level of each and every asset with as much accuracy as possible”.

The project should focus on offshore or on onshore wind power systems and make optimal use of previously developed models. Validation should be carried out with data of existing wind farms. Cooperation with wind energy suppliers, OEM's, developers and O&M services can make the available data more accurate, resulting in better, more sustainable and eventually circular products and sector. The project should also sufficiently invest in delivering a cyber-secure system. The projects is expected to build also on the digital twins developed under Destination Earth, which envisage to develop a high precision digital model of the Earth to model, monitor and simulate natural phenomena and related human activities.

For the offshore digital twin projects the impact of other blue economy sectors, islands, different land-sea interactions for near shore wind farms should be considered.

For onshore digital twin projects, the build environment and different landscapes should be considered, and cooperation is envisaged with the selected projects under topic HORIZON-CL5-2021-D3-03-05 Wind energy in the natural and social environment.

It is expected that one project on offshore digital twin will be funded and one on onshore digital twin.

To support rapid market uptake, widespread application and further innovation based on the developed solutions, projects are invited to use Open-Source solutions when appropriate and clarify in case they choose not to use Open Source, so that they can support the planning of future large scale offshore wind installations. Free licensing is also a possibility to consider to support rapid market uptake.

Selected projects will be required to share knowledge. Projects will acquire performance-related data in a standard format to support advancement and validation of R&I for the benefit of all projects through Artificial Intelligence methods. This data and relevant meta-data may be shared with other projects (not supported through Horizon Europe, including relevant projects supported through the Innovation Fund) on reciprocal terms, preferably leveraging on the tools and services provided by the European Open Science Cloud (EOSC) and exploring workflows that can provide “FAIR-by-design” data, i.e., data that is FAIR from its generation, and with EU-based researchers having a legitimate interest. The selected projects are expected to cooperate with the project selected under the call [CSA for data-sharing between renewable energy R&I project to advance innovation and competitiveness].

The selected projects are expected to contribute to the BRIDGE initiative¹⁷⁵, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

¹⁷⁵ <https://www.h2020-bridge.eu/>

HORIZON-CL5-2023-D3-02-15: Critical technologies to improve the lifetime, efficient decommissioning and increase the circularity of offshore and onshore wind energy systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least two of the following expected outcomes:

- Improved overall lifetime, reliability, recyclability, sustainability, operability and maintainability of onshore and offshore wind turbines and foundations/substructures.
- Enhanced overall sustainability of wind energy systems based on mainstreamed Life Cycle Analysis addressing social, economic and environmental aspects, as well as improved circularity.
- Mainstreamed affordable high life-cycle performance, life extension, more efficient decommissioning, and improved circularity of wind turbine components.
- Potential new markets in wind turbines recycling and/or re-purposing.

Scope: Innovative technologies to improve the lifetime, efficient decommissioning and increase the circularity of wind energy systems. Project can address one of the following points:

- Development of improved, more damage-tolerant materials (composites and adhesives) considering different external conditions in which the materials are used (consider very low/high temperatures, ice, corrosion, erosion).

- The development of improved manufacturing procedures for turbine components and construction methods for wind turbine farms and design methods for wind turbine components.
- The development of materials and interfaces for joints of major load-carrying parts like main spars (split blades and tower parts).
- The development of bio-based fibres and resins with improved mechanical properties.
- Lifetime extension by innovative design for increased resilience and repair solutions for in the first-place wind turbine components like blades, drive train and generators', and support structures.
- New installation, decommissioning, and condition monitoring technologies and operation and maintenance methodologies (e.g. remote controlled devices for in situ repairs by robots).
- New efficient recycling technologies for wind energy components.
- Alternatives in materials/new advanced materials.
- New technologies for effective and environmentally friendly decommissioning of wind energy systems.

But it is not excluded to consider other solutions.

This R&I need is critical for onshore wind given the large volumes of capacity to be decommissioned in the next decade. The R&I need was also identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to 'systematically integrate the principle of 'circularity by design' into renewables research & innovation'.

HORIZON-CL5-2023-D3-02-16: Accelerating the green transition and energy access in Africa

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility</i>	The conditions are described in General Annex B. The following

<i>conditions</i>	<p>exceptions apply:</p> <p>The following additional eligibility criteria apply:</p> <p>For the consortium, in addition to the standard eligibility conditions for consortia, at least two entities established in at least one African Union member state must be part of the consortium.</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Technology Readiness Level</i>	<p>Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.</p>
<i>Award criteria</i>	<p>The criteria are described in General Annex D. The following exceptions apply:</p> <p>For the criterion 'Quality and efficiency of the implementation', in addition to its standard sub-criteria, the following aspect shall constitute a major element: Proven access to necessary land and / or permits for operation at the time of application and / or convincing risk management regarding delayed availability of land or permits. Risk management can include go / no-go decisions at mid-term.</p>

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Technologically reliable and economically viable renewable energy solutions by 2030.
- Improve climate adaptation and/or climate mitigation potential of the solutions compared to other technologies/solutions.
- Strengthening of the joint EU-AU Climate Change and Sustainable Energy Collaborative Partnership efforts, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.
- Proven positive environmental, health, climate, social and economic impacts of the renewable energy solutions.
- Acceleration of the achievements of the African countries' targets of the Paris Agreement.

Scope: The proposal should demonstrate innovative sustainable renewable energy solutions that improve climate adaptation and/or mitigation potential compared to other technologies/solutions in the African social, economic and environmental contexts. The proposal may address development of renewable energy sources, including solutions for off-grid communities, and their integration into the existing energy system. Proposals should

consider the generation of renewable energy, and where relevant the transmission, and the use of storage/battery systems.

The action should cover either urbanised or rural contexts in Africa. It should contribute to reducing the stress on the water-energy-food nexus, with the aim of providing sustainable renewable energy access and creating other socio-economic benefits such as improved health, economic wealth and jobs.

Actions should design, construct, commission and operate the demonstration installation. Actions should also develop and implement a tailored value chain approach, identifying the most suitable manufacturing value chains, on the basis of the local context, local material supply chain(s) and local workforce, with the objective of ensuring sustainable local economic development. African SMEs are expected to play an important role in the overall value chain and to contribute in the identifying the needs. Actions should also include the identification of technical, vocational and educational needs of the workforce and propose relevant training and qualification activities. Actions should finally define a market and business strategy that could take into consideration funding from financial instruments and aid programmes to ensure impact through a quick and viable commercial take-up of the technological solution demonstrated.

Social innovation should be considered. The business plan should include appropriate consideration of available financial support instruments (local, regional and/or international) to enhance the speedy market deployment of the solution.

Proposals should include a life cycle analysis showing the impact of the proposed solutions when compared to other technologies/solutions on the environment, on climate change targets and on the social and the economic dimensions, taking a cradle to grave viewpoint. The life cycle analysis should take a cradle to grave approach. Proposals should adopt a circular economy approach.

As the demonstration installation will be located in Africa, relevant African partners have to participate in the implementation of the project. A balanced involvement in the activities of the projects of European and African partners will be considered an asset in the evaluation.

Actions should also participate in and contribute to the African Union¹⁷⁶ - European Union collaborative research action on Climate Change and Sustainable Energy, in particular through cooperation/collaboration with the project LEAP-RE, “, www.leap-re.eu.

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-03

Conditions for the Call

Indicative budget(s)¹⁷⁷

¹⁷⁶ “African Union member states” includes countries whose membership has been temporarily suspended.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁷⁸	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 10 Oct 2023				
HORIZON-CL5-2023-D3-03-01	RIA	9.00	Around 3.00	3
HORIZON-CL5-2023-D3-03-02	IA	12.00	Around 6.00	2
HORIZON-CL5-2023-D3-03-03	IA	11.00	Around 11.00	1
HORIZON-CL5-2023-D3-03-04	IA	11.00	3.00 to 4.00	3
HORIZON-CL5-2023-D3-03-05	IA	5.00	Around 5.00	1
HORIZON-CL5-2023-D3-03-06	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D3-03-07	RIA	6.00	Around 3.00	2
HORIZON-CL5-2023-D3-03-08	CSA	0.60	Around 0.60	1
Overall indicative budget		64.60		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex

¹⁷⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹⁷⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

	D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-01: Increasing the efficiency of innovative static energy conversion devices for electricity and heat/cold generation

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to develop further the harvesting of renewable energy in areas/conditions where other conversion systems are less efficient, less convenient or not possible.

The results are expected to contribute to at least three of the outcomes in A and B:

A. Increased potential for wider application of electricity and heat/cold static generators due to increased efficiency of energy conversion devices using physical effects such as:

- Thermoelectric -> Thermoelectric Generators (TEG)
- Thermovoltaic -> Thermovoltaic Generators (TVG)
- Thermionic -> Thermionic Generators (TIG)
- Pyroelectric-> Pyroelectric Generator (PEG)
- Electrocaloric -> Electrocaloric Generator

B. Optimised construction and application of the above-mentioned devices for:

- heat recovery applications with electricity generation;
- heat/cold generation from electricity;
- applications in areas such as industrial, automotive, solar, geothermal, data centres, buildings applications, etc.

Scope: Projects are expected to implement both the activities in (1) and the validation/demonstration in (2) for the technologies listed above addressed individually and/or as combination of them or with other generation technologies (e.g., Thermionic Photovoltaic TIPV) as described below:

1. Development of at least three of the above-mentioned technologies involving the activities listed below. These can be complemented among them and/or with others pertinent to the topic.

- Simulation, analysis, design, test and validation/demonstration of innovative generators such as the ones described above converting directly heat/cold into electricity with applications in energy waste recovery (e.g., industry, geothermal, data centres, buildings, automotive, etc.).
- Simulation, analysis, design, test and validation/demonstration of innovative generators converting electricity directly in heating or cooling systems (e.g., in industrial processes such as metallurgy, semiconductor lithography, etc., to cool or heat control elements, to cool Li-Ion-Batteries of electric cars, temperature control in data centres, etc.).
- The development of new materials to overcome the drawbacks of the above-mentioned technologies such as of their interdependent electrical and thermal properties, etc.
- Innovative designs of the above-mentioned types of generators that allow better integration into energy conversion systems, from the point of view of efficiency and environmental impact.
- Potential use of nanotechnology for the development of the above-mentioned innovative energy conversion technologies.

2. Validation/demonstration of the activities developed in (1) with at least one pilot for each technology in different EU Member States/Associated Countries.

HORIZON-CL5-2023-D3-03-02: Integration of renewable gases, other than hydrogen or methane, and which have not access to gas grids and interfacing with electricity and heat sectors

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Accelerate the integration of unrefined renewable gaseous fuels in the energy system.
- Increase flexibility, reliability and security of renewable energy supply in the energy sector.
- Increase integration of electricity and heat/cooling sectors with gas grids.

Scope: Demonstration of decentralized production of renewable gaseous energy carriers other than hydrogen and purified biomethane, namely biogas and syngas for example, and its integration in local energy systems and/or energy consuming industries for direct electricity and heat and cooling production. Demonstration of the integration of small and flexible modular gas production units, its associated infrastructure and development of digital interfaces for the connection to electricity and heat/cooling sectors are included. The integrated modules and components should be optimized to increase flexibility, security, affordability, and robustness to the local energy supply. Conditions for injection to the grid of renewable unrefined gases should be identified. A techno-economic analysis should be

included to address the cost-effectiveness of the integrated solution. A life Cycle Analysis should be carried out for the assessment of the GHG emission reduction due to the renewable gas integration. Interfaces to governance issues of system integration, as for example market design, network regulation, CO₂ market, renewables support, etc. should be addressed. Effects of Community involvement should be addressed with an analysis of socioeconomic sustainability.

HORIZON-CL5-2023-D3-03-03: System approach for grid planning and upgrade in support of a dominant electric mobility (vehicles and vessels) using AI tools

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 11.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute of the following expected outcomes:

- AI-based prediction of most convenient locations that optimize grid resources and upgrades around recharging pools for EVs and electric HDVs.
- Developing of spatial mapping models and software tool for location decision-making with a comprehensive focus, including major highways, industrial zones (depot charging), urban nodes (e.g., for overnight charging) and less-densely populated areas.
- Simulation, analysis, design, test and demonstration of smart and bidirectional charging schemes and their integration into flexibility markets that allow to minimise the impact on grid planning and connection of high-power recharging pools for recharging EVs, and especially HDVs on more cost-intensive locations, and that ensure benefits to consumers based on smart charging energy service models.

- Exploration of the impact of different charging methods, including cable-charging, wireless charging and electric road systems covering either catenary as inductive coils embedded in the road.
- Analysis, design, testing and developing of a cyber security model that can simulate and accurately represent attack propagation from recharging infrastructure entry vectors, informing the development of efficient strategies and lines of defence to mitigate these vulnerabilities for the different relevant stakeholders.

Scope: The activities are expected to include at least the following aspects:

- Definition and development of new AI-based tools to predict, estimate and plan the deployment and associated challenge for utilities (from an EV recharging ecosystem viewpoint - CPO, DSO and TSO) on how to deal with the increasing upcoming demand in numerous new locations, particularly during peak periods.
- Understanding on how to effectively deploy the required grid connection (and power) in less densely populated areas, exploring the impact of installation of batteries to expand the grid in combination with renewables.
- Development of a coherent energy system planning for electric mobility, considering both the needs and impact for recharging of EVs and onshore power supply of vessels in maritime ports and inland waterways.
- Development of new services for consumers (EV and HDV owners, leasers, etc.) based on smart charging that valorise the flexibility in the wholesale, home optimisation and/or grid services markets. Integration of smart charging services with flexibility from other devices (e.g. demand response) would be an added value for the project.
- There is an increasing risk for the occurrence of a scenario where EVs and/or recharging stations could be hacked simultaneously, causing a disruption to grid operations, propagating rapidly with dire consequences, such as blackouts and overall affection of the frequency stability of the grid. The project should bridge the gap between recharging infrastructure operators, EVs and the grid (DSOs, TSOs), identify existing weaknesses and risks for attack spread.
- The developed solutions should assess their environmental impact in particular with regards to their energy consumption.

The selected projects are expected to contribute to the BRIDGE initiative¹⁷⁹, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

¹⁷⁹ <https://www.h2020-bridge.eu/>

HORIZON-CL5-2023-D3-03-04: Digital tools for enhancing the uptake of digital services in the energy market

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 3.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 11.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Projects’ results are expected to contribute to all of the following outcomes:

- Development and uptake of innovative data-driven cross-sector integrated services, solutions and products using cross-sectorial data resulted from other sectors than energy (e.g. data economy, health, finance, security) that empower consumers and facilitate consumer investment in the energy transition (e.g. renewables, energy efficiency, renovation, demand response, storage).
- Development and fast market-uptake of digital twin models of household energy consumers to help consumers, citizens, energy suppliers, aggregators and energy communities to optimise data-driven energy (and other sector) services and to enhance digital energy literacy.
- Greater access for consumers to the wide range of emerging services and applications that will be present in the market resulting from data sharing and benefiting from increased interoperability.
- Increased simplification of management and improvement of quality of new and current energy services and new digital platforms, smart meters and tools to provide consumers with seamless omni-channel experiences.

- Assessment of the implications for market design (energy and flexibility markets) of a wide uptake of digital tools and propose relevant modifications to flexibility services and related processes to contract, activate, measure and settle flexibility.
- Creation of value and direct benefit for the consumers and support digital empowerment and energy literacy of citizens: European citizens are educated, motivated, and empowered to use digital tools to be an active participant in the just energy transition.

Scope: Digitalisation develops faster than the ability of society to adjust. Digital technologies are a driving force for empowering citizens in taking on an active role in the just energy transition. Increased acceptability of new digital technologies is pivotal: actions should focus on benefits of new digital services and users experience to overcome the expected friction of end-consumer on boarding, developing innovative tools for engagement and literacy. Social innovation tools and multi-disciplinary approaches and engagement of policy makers at various levels, the private sector, civil society and citizens at large are required.

Accordingly, proposed activities will address all of the following:

- Use the data real time provided by real time sensors/ Internet of Things and real time computing resulting from other sectors than energy (e.g. data economy, health, finance, security) to generate new businesses and new ways of benefiting the economy and society by developing of innovative data-driven cross-sector integrated services, solutions and products.
- Help consumers and citizens navigate the new digital technologies entering the energy market, taking into consideration the cross sectorial dimension alongside the sector-specific one, also exploring the possibility of using, among others, AI-based assistant tools.
- Trigger and support the development of a digital tool allowing citizens to visualise and access to all the energy-related data they produce and share with third parties, thus helping to exert their right to understand and control their data.
- Test the developed cross-sector services in at least 3 countries. In the selection of pilots, gender, demographic, geographic and socio-economic aspects should be duly taken into account.
- Develop and test, in at least 3 countries, a digital twin of the (household) energy consumer, making use of AI to assist the consumer (both in terms of optimising the service as well as enhancing digital energy literacy and enhancing understanding and trust of the AI used).
- The digital twin solutions should be developed and made available as Open-Source solutions, while making sure that contributors are recognised and fairly compensated, respecting well defined rules and within a network of trusted data, which guarantees security and sovereignty of data and services in an Open Source way so that the developed software is available.

- Contribute to the communication, outreach and dissemination strategy of the Communication on Digitalisation of the Energy System.

Projects are required to utilize the data exchange infrastructure that is being developed under ongoing EU-funded under Horizon 2020, Horizon Europe and the Digital Europe Program.

The project is required take into account, and collaborate with, where considered necessary, existing Living Labs (e.g. EnergyVille, TomorrowLab and living labs funded entirely by EU projects as study or demonstration site) to test integrated consumer services the ongoing relevant Blueprint projects from the Erasmus + program, relevant initiatives by Digital Innovation Hubs, the European Climate Pact, EC Digital Education action plan and any other relevant initiative.

Projects are required to seek synergies with Horizon Europe instruments, including those of bottom-up nature like ERC, MSCA, EIT KICs, as well as its European partnerships.

Cooperation with activities of the Green Powered Future Mission (Pillar 3) of Mission Innovation is encouraged¹⁸⁰.

The selected projects are expected to contribute to the BRIDGE initiative¹⁸¹, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Moreover, projects are expected to take into account the outcomes of the work of the Citizens and Consumers Engagement Working Group and data coming from the Consumers Empowerment Benchmark developed by the European Commission.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D3-03-05: Creation of a standardised and open-source peer-to-peer energy sharing platform architecture for the energy sector

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

¹⁸⁰ Applicants are reminded that legal entities established in China are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.

¹⁸¹ <https://www.h2020-bridge.eu/>

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 5.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Develop an independent, EU-validated flexibility and peer-to-peer trading solution for consumers willing to engage in such operations, to the benefit of the integration of Distributed Energy Resources (such as solar panels, batteries and electric vehicles, but also demand-response and flexible heat pumps and heaters considered as a resource) within the electricity network.
- Such an alternative should be open source, freely accessible, free of IPR, easy to maintain, and ensure that the final ownership of the tools can remain in community hands, and that these tools are available for reuse.
- Increase consumer engagement and tool’s acceptability.
- Illustrate the relevant services that are supported by this peer-to-peer trading platform (flexibility services for TSO, DSO, self-consumption).
- Ensure policies of operations, integration and usage of blockchain technologies and underlying data for all stakeholders.
- Ensure interoperability and contribute to standardisation of blockchain energy applications

Scope: The activities include, but are not limited to:

- Defining the core operations that a flexibility and peer-to-peer trading platform should execute in order to:
 - o Guarantee optimal valorisation and integration of DER (such as solar panels, batteries and electric vehicles, but also demand-response and flexible heat pumps and heater considered as a resource) within the electricity network.

- o Take into account network constraints, including through the use of price signals to foster flexibility.
- o Meet the local consumers' needs and characteristics.
- Developing an AI-based software that uses machine learning processes to integrate core operations and local grid constraints (including when channelled through price signals) in order to adapt to variations and changes in grid conditions.
- Testing and simulation cases for blockchain-based trading operations following an agile methodology with the objective to get a fully functional trading tool within the project lifetime. The design of the platform should reflect the multi-actor, open-ended nature of decentralised use of energy. Proposals should account for a complex system change process, and prescribe evolutionary pathways for the platforms, account for their socio-technical interdependencies, and define and validate feasible entry points.
- Developing field studies in citizen energy communities / renewable energy communities to integrate bottom-up approaches.
- Setting rules for using the tool
- Involving energy cooperatives or citizen energy communities (see Article 16 of the Commission's Directive 2019/944 on common rules for the internal market for electricity (IEMD)) / renewable energy communities (see Article 22 of the Commission's Directive 2018/2001 on the promotion of the use of energy from renewable sources (RED II)) in each selected project and ensure that the final ownership of these tools can remain in community hands, and that they are available for reuse (a particular consideration will be taken with respect to data security and potential related restrictions thereof).
- Developing an open, available and operational platform to strengthen business models, and define which these business models are.
- Exploring and comparing advantages / disadvantages of existing and new market making methods (Order Book-based systems and Liquidity pool-based Automated Market Makers) for a peer-to-peer energy exchange.
- The project should be developed by taking into account both a technology performance perspective and a long-term sustainability roadmap.

The developed solutions should be freely available to citizens, energy cooperatives and citizen/renewable energy communities.

Solutions should be developed and made available as Open-Source solutions, while making sure that contributors are recognised and fairly compensated, respecting well defined rules and within a network of trusted data, which guarantees security and sovereignty of data and services.

The selected projects will cooperate and with other relevant projects through regular common workshops, exchange of non-confidential reports, etc.

The selected projects, especially those that are testing peer-to-peer feasibility in real conditions and environments (such as living labs or other types of sandbox initiatives), are expected to contribute to the BRIDGE initiative¹⁸², actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Solutions should be developed considering integration into existing power markets where appropriate. The selected projects should associate energy regulators in their governance and should preferably be located in the territory of EU Member States/Associated countries where few peer-to-peer energy trading pilot projects have been setup so far.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. This is all the more important in the project at hand that a modification of consumers incentives (through price-signals for instance) can trigger changes of behaviour, which in turn can have positive effects on the electricity system, and interesting applications in terms of flexibility services, optimization of use of excess RE production, as well as congestion management.

HORIZON-CL5-2023-D3-03-06: Components and interfacing for AC & DC side protection system – AC & DC grid: components and systems for grid optimisation

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

¹⁸² <https://www.h2020-bridge.eu/>

<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
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Expected Outcome: Project results are expected to contribute to all the following outcomes:

A. Protection:

- AC & DC side protection strategies and readiness of their functional design, to support grid optimal architecture planning and prepare project tendering.
- Methodology to assess admissible temporary loss of transmitted power in case of DC fault.
- Multi-vendor interoperable MVDC/HVDC grid protection strategies and design.
- AC & DC side protection system functional design for fully selective, non-selective and partially selective fault clearing strategies, including the connection to low-inertia AC systems.

B. Congestions in AC or DC grids:

- Innovative Power Electronics-based technologies properly placed in the grid to address congestion due to the injection of decentralised energy in a centralised-based electricity system.
- Optimisation of the power flows by shifting power transfer from loaded to less loaded lines.
- Grid reinforcement avoidance.

Scope: Projects are expected to implement activities in (1) and the practical demonstration in (2) as described below:

1. Development of R&I activities, methodologies and tools for at least two of the sub-topics in A (a, b or c) and B. These can be developed/complemented among them and/or with others pertinent to each sub-topic:

A) Protection:

a. Methodology to assess admissible temporary loss of transmitted power in case of DC fault:

- AC-DC transient stability, when DC transmitted power is temporarily and partially interrupted, in case of a DC fault.
- Impact of reactive power supply transient interruption (converter blocking).
- In case of MVDC/HVDC-connected Off-Shore Wind farm: coordination of control actions from MVDC/HVDC and wind turbines.

- Anticipation of new system dynamics due to high PEID penetration.
- Impacts of partially selective and non-selective versus fully selective DC fault-clearing strategies.
- Recommendation for AC-DC system design and DC protection design.

b. Multi-vendor interoperable MVDC/HVDC grid protection

- Improved methodologies for the determination of functional requirements of DC grid protection in a technical and vendor neutral manner.
- Standardised validation tests for de-risking interoperability issues.
- Specification of protection component and auxiliary ratings.
- DC substation Communication architecture and protocols (e.g., IEC 61850 for DC).
- Protection system simulation models and information exchange.

c. HVDC grid protection strategies and design

- Methodologies for the protection of mixed (OHL/cable, bipolar/monopolar) DC grids.
- Methodologies to optimally determine the optimal MVDC/HVDC grid protection system, including combined selective, non-selective and partially protection schemes within the same DC grid.
- Development of converter assisted MVDC/HVDC grid protection.
- DC station design and optimisation from protection point of view.
- AC & DC side protection system functional design for fully selective, non-selective and partially selective fault clearing strategies, including the connection to low inertia AC systems

B) Congestions in AC or DC grids:

- Simulation, analysis, design, development, test and demonstration of advanced Power Electronics-based equipment inserted appropriately in specific points in the grid to decongestion the lines or cables.
- Cost Benefit Analysis compared to other solutions (e.g., the use of DC systems, etc.) at system level and covering the operating life of the equipment.

2. Demonstration, test and validation of the activities developed in (1) in at least two pilots in different EU Member States/Associated Countries.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-07: Digital solutions for defining synergies in international renewable energy value chains

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>The consortium must include, as an associated partner or beneficiary, at least one legal entity established in a Mission Innovation Country¹⁸³, not being Member State or Associated Country.</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to some of the following expected outcomes:

- Advance the European and global scientific basis, European leadership and global role in the area of renewable energy and renewable fuels and related energy value chains while creating evidence for policy making by developing novel digital solutions.
- Provide digital breakthrough solutions for promoting the increase of the global renewable energy share.
- Reinforce the European scientific basis through international collaboration while increasing the potential to export European renewable energy technologies and ensuring political priorities in the context of sustainable global energy value chains.

¹⁸³ <http://mission-innovation.net/>

- Improve reliability of system components, advanced and automated functions for data analysis, diagnosis and fault detection, forecasting and model-predictive control frameworks, ancillary services for the stability of the network; maintenance planning and/or reporting.

Scope: Development of novel real time and open data monitoring and/or simulation solutions (e.g. including digital twins) for sustainable energy production and consumption, predictive modelling and artificial intelligence for the analysis of international renewable energy value chains and for internationally aligned decision-making in cooperation with international partners from Mission Innovation Countries. To ensure trustworthiness, wide adoption by user communities and support EU policy-makers, actions should promote the highest standards of transparency and openness, going well beyond documentation and extending to aspects such as assumptions, models and data related to renewable energy and fuels.

The current topic is an amended republication of topic HORIZON-CL5-2022-D3-02-01 which has been cancelled.

Cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-08: Support to the SET Plan IWG on hydrogen

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 0.60 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 0.60 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results are expected to contribute to the following outcomes:

- Organisational, logistic and secretarial support provided to the SET Plan Implementation Working Group on hydrogen.

- Smooth implementation through supporting the actions of the SET Plan for hydrogen in the coming years covering the whole value chain.

Scope: The Implementation Working Group (IWG) on hydrogen set up in 2023 aims at implementing part of the Strategic Research and Innovation Agenda (SRIA) of the European Research Area (ERA) pilot on green hydrogen, and coordinating the work on hydrogen previously split between different IWGs of the SET Plan. This ERA Pilot on green hydrogen SRIA addresses specifically the need to ensure mutual coordination on an ongoing basis among national and regional hydrogen R&I programmes. It calls for, through a bottom-up approach, more ownership by member states and associated countries, which also means more financial and political commitment. It aims to maximise cooperation and synergies among member states and associated countries, and avoid inconsistencies, duplications, and fragmentation of measures. The activities of the hydrogen IWG build on the SRIA and range from the support of the development of hydrogen technologies to the fostering of collaboration and coordination within the SET Plan countries to ensure their active involvement. The support action is intended to facilitate the work of the hydrogen IWG by further defining its mission, supporting the preparation of the Implementation Plan (IP) on hydrogen and ensuring synergies with other SET Plan IWGs, domains and objectives, with activities focusing on:

- Organisational support to the Implementation Working Group on hydrogen.
- Analysis of the ERA pilot on green hydrogen SRIA and identification of the actions to be taken on by the IWG in the IP.
- Proposals to further develop the work initiated by the SRIA, for the parts relevant for the SET Plan.
- Coordination with other SET Plan IWGs to ensure complementarity of the actions.
- Coordination with other initiatives/projects and establishment of links with stakeholder's fora.
- Facilitation of exchange between member states and stakeholders on best practices and lessons learned.
- Dissemination and networking activities with other existing ETIPs and IWGs (e.g., joint workshops, thematic conferences, webinar series, regular exchanges, etc.).
- Development and implementation of robust outreach approaches, development of assessments of risks (including environmental ones) and design and implementation of solutions, and societal engagement actions to span across the EU and Associated Countries.
- Organisation and management of documents and files with feed-in of relevant outputs of this CSA into the SET Plan information system (SETIS).

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2024-D3-01

Conditions for the Call

Indicative budget(s)¹⁸⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁸⁵	Indicative number of projects expected to be funded
		2024		
Opening: 12 Sep 2023 Deadline(s): 16 Jan 2024				
HORIZON-CL5-2024-D3-01-01	IA	24.00	Around 12.00	2
HORIZON-CL5-2024-D3-01-02	IA	6.00	Around 3.00	2
HORIZON-CL5-2024-D3-01-03	IA	20.00	Around 10.00	2
HORIZON-CL5-2024-D3-01-04	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-05	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-06	RIA	9.00	Around 3.00	3
HORIZON-CL5-2024-D3-01-07	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-08	IA	38.00	18.00 to 20.00	2
HORIZON-CL5-2024-D3-01-09	COFUND	10.00	Around 10.00	1
HORIZON-CL5-2024-D3-01-10	RIA	27.00	Around 3.00	9
HORIZON-CL5-2024-D3-01-11	IA	16.00	Around 5.00	3
HORIZON-CL5-2024-D3-01-12	IA	10.00	Around 5.00	2

¹⁸⁴ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹⁸⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL5-2024-D3-01-13	RIA	13.00	Around 6.00	2
HORIZON-CL5-2024-D3-01-14	RIA	13.00	Around 4.00	3
HORIZON-CL5-2024-D3-01-15	RIA	16.00	5.00 to 5.50	3
HORIZON-CL5-2024-D3-01-16	IA	8.00	Around 8.00	1
HORIZON-CL5-2024-D3-01-17	IA	12.00	Around 6.00	2
Overall indicative budget		246.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-01-01: Alternative equipment and processes for advanced manufacturing of PV technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 24.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements. To ensure security of supply, retaining the whole value chain in EU Member States/Associated countries is essential; technology de-risking is a necessary step towards this direction. Consequently, project results are expected to contribute to all of the following outcomes:

1. Contribute towards establishing a solid European PV innovation and production base.
2. Reduce the CAPEX and OPEX in the PV solar production chain, ultimately leading to cheaper modules and lower LCOE.
3. Reinforce the sustainability of the European PV value chain building a secure, resilient, and diverse domestic energy sector industrial base.

Scope: Proposals are expected to:

- Demonstrate alternative processes and equipment for PV manufacturing with reduced CAPEX, OPEX, energy and material consumption and implement Industry 4.0 concepts.
- Increase the productivity and sustainability of large-scale PV manufacturing equipment and processing, for example by the enhancement of: i) throughput (e.g. wafers or roll area /time or module area/time) ii) yield (process & quality control) iii) availability (e.g. optimisation of uptime & service time) and iv) quality control.
- Involve multidisciplinary consortia including industrial partners.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and

deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2024-D3-01-02: Low-power PV

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁸⁶ .

Expected Outcome: Energy autonomous applications capable of generating their own energy by harvesting ambient energy from the environment to completely eliminate the need for a power source or at least assist it, have gained significant interest in recent years. Photovoltaic energy conversion is a viable choice for energy harvesting due to its high conversion efficiency and compatibility with low lighting conditions.

¹⁸⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Consequently, project results are expected to contribute to the following expected outcome:

- Increase the potential of PV for low power, low irradiation applications (harvesting energy in low light intensity and/or artificial light conditions).

Scope: Photovoltaic energy harvesting in low light conditions such as indoors, or under artificial or diffuse light can be used to power sensors, as well other low-power electronics. Efficient energy harvesting combined in an energy system with storage unit and low power electronics, can enable a wide range of applications, integrating new functionalities, for example autonomous sensors, domotics, remote monitoring, variable transmission applications and portable devices in general.

Proposals are expected to validate novel and low-environmental impact PV materials, PV architectures and suitable substrates for the specific low power applications that take into account the light intensity, light spectrum and application itself. PV system performance is expected to be tailored to meet the application-specific power and energy requirements and application – related standards. Proposals should include a clear definition of the use case and lifecycle considerations, e.g. business models, circularity by design aspects, certification, etc.

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2024-D3-01-03: Demonstration of improved intermediate renewable energy carrier technologies for transport fuels

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

	additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁸⁷ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Support de-risking the technology, boost scale-up of flexible intermediate bioenergy and synthetic renewable energy carriers and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in transport.
- Increase flexibility, reliability and security of renewable energy supply in the transport sector.
- Increase available options for better integration of the energy system linking renewable energy production, storage and use via renewable energy intermediates.

Scope: Demonstration of technologies for the production of advanced intermediate bioenergy and synthetic renewable energy carriers from biogenic residues and wastes, microalgae, biogenic CO, CO₂ or nitrogen and renewable hydrogen and all forms of renewable energy with reduced cost and GHG emissions above the state of the art. Proposals are expected to demonstrate that conversion technologies have already reached pilot scale TRL 5. The finished quality is expected to be suitable so that the intermediates can be either directly upgraded in existing refinery infrastructures and/or further purified and processed in existing chemical infrastructures to drop-in liquid and gaseous advanced biofuels and synthetic renewable fuels, or directly used for shipping propulsion or in other off-road transport. Examples are demonstration of production of bio-oils, raw alcohols, bio-liquids, biogas, syngas and thermally pre-treated solid biomass fuels from biogenic residues and wastes and microalgae oils through chemical, biochemical, thermochemical, biological, electrochemical pathways, as well as synthetic renewable analogues. The integration of these intermediates in transport and their application in hard to electrify transport sectors should be presented. The

¹⁸⁷ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

logistics for transportation and storage of the intermediates should be addressed. The sustainability and GHG reduction should be addressed on a life-cycle assessment basis. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2024-D3-01-04: Improvement of light harvesting and carbon fixation with synthetic biology and/or bio-inspired//biomimetic pathways for renewable direct solar fuels production

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least 3 of the following expected outcomes:

- Availability of disruptive and sustainable solar fuel technologies in order to accelerate the replacement of fossil-based energy technologies with more efficient use of primary solar energy in solar fuel production.
- Reduced cost and improved efficiency of solar-based renewable fuel technologies and their value chains by addressing rate-limiting steps in the solar fuels value chain.
- Increase technology leadership, competitiveness and technology export potential of European industry in possibly game-changing solar fuel and synthetic biological technologies.

- Enhanced sustainability of solar fuels, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).
- Increasing the European energy security and reliability by improving the solar fuel conversion efficiency as well as maintaining and fostering the European global leadership in affordable, secure and sustainable solar fuel technologies.

Scope: Development of novel in-vivo or in-vitro biochemical and/or bio-inspired/biomimetic pathways for solar fuel production with increased efficiency in comparison to light and dark reactions of natural photosynthesis by synthetic biological and/or bio-inspired/biomimetic approaches. The aim is to achieve a significant improvement of components of both, light harvesting and carbon fixation, which are rate limiting for the conversion of solar energy to renewable fuels. Proposals are expected to include case studies for analysing the potential and impact of the technology for future application at scale and analyse possible interfaces with other solar fuel technologies, with a particular focus on socioeconomic and environmental sustainability including circular economy, social, economic and environmental aspects and cost-effectiveness. All relevant aspects of safety of the technology are expected to be addressed. Hydrogen as a fuel and end-product is excluded.

Projects are expected where possible to collaborate with and contribute to the activities of the Coordination and Support Action funded under the topic HORIZON-CL4-2021-RESILIENCE-01-16

HORIZON-CL5-2024-D3-01-05: Development of carbon fixation technologies for biogenic flue gases

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Availability of disruptive sustainable bioenergy technologies with negative carbon dioxide emissions.
- Increase technology leadership, competitiveness and technology export potential of European industry.
- Reduced cost and improved efficiency of sustainable bioenergy technologies and their value chains.
- Enhanced sustainability of bioenergy, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

Scope: Development of biological and chemical solutions to use the effluent gases from bioenergy combustion systems and upgrade biogenic carbon emissions for the production of renewable energy carriers with renewable hydrogen for later reuse as feedstock for energy needs and achieving carbon circularity. This requires system components (e.g. catalysts), which are cost-effective and robust to flue gas toxicity and interface with the underlying bioenergy combustion system without compromising system performance in respect of technical efficiency and sustainability.

The effluent fixing solution has to be implemented in the conditions of the bioenergy combustion system and provide an integrated structure at the TRL requested. The reuse of the biogenic emissions should be addressed. The assessment of the combustion gas upgrading should be done at pilot scale and cost analysis of how this is a beneficial carbon capture and use solution should be provided.

Socio-economic aspects including SDGs and impacts when applying such solutions in regions in transition from coal or other fossil fuels should be analysed and illustrated in the proposal.

HORIZON-CL5-2024-D3-01-06: Innovative applications/integration of geothermal heating and cooling in industry

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- High integration of geothermal heating and/or cooling in different industry sectors with operation flexibility considering start-up time and ramp-up rate, and maximum cascaded use of thermal energy.
- Increased industry, region, city and citizen trust and acceptability for geothermal energy.

Scope: Based on geothermal energy, the following is expected to be achieved: explore new heating and/or cooling concepts for industrial sectors which have to decarbonise their production lines using renewable systems. enable the smart use of thermal grids with emphasis on flexible supply of resources, adapted to different source temperatures and varying demand; and position geothermal utilisation (including underground storage) as a crucial pillar for the (heat and/or cold) transition of industrial energy systems. Projects should consider the application of cascading residual geothermal waste heat to neighbouring industries or the built environment and should include the integration of geothermal and heat pump systems, energy piles, or energy sheet pile walls, consider the use of alternative cycle working media.

Activities related to geothermal heat for industry and agriculture, underground thermal energy storage (UTES) including high-temperature storage, innovative and multiple uses for geothermal energy and side-products, balneological systems, and design and operation of geothermal doublets can be considered.

Activities are required to assess the environmental sustainability of geothermal heating and/or cooling applications. The applied technologies should not significantly harm the environment (Do No Significant Harm principle). It must be ensured that negative impacts on ecosystems and biodiversity, including negative impacts on (or pollution affecting) air, water or soil quality, are addressed through mitigation policies.

HORIZON-CL5-2024-D3-01-07: Development of hydropower equipment for improving techno-economic efficiency and equipment resilience in refurbishment situations

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at all of the following expected outcomes:

- Keeping the availability of the existing hydropower fleet with an important role in the future power market as flexible power suppliers.
- Increase technology leadership, competitiveness and technology export potential of European hydropower industry.
- Reduced cost and improved efficiency of refurbished hydropower installations.
- Enhanced sustainability of refurbished hydropower, taking fully into account and balancing between circular economy, social, economic and environmental aspects in line with the European Green Deal priorities including energy and climate targets and biodiversity.

Scope: Development of hydropower equipment for improving techno-economic efficiency and equipment resilience in refurbishment situations of existing hydropower plants, which are outdated in respect of efficiency, power market interfacing, climate change adaptation and environmental sustainability, in particular also in respect of biodiversity. In scope are novel technologies, which improve the efficiency and economic parameters of existing hydropower plants during refurbishment without requiring substantial modification of the hydraulic system and by implementing circularity by design, e.g., low-friction and resistant materials

and technical solutions that can minimize tear and wear in future operation modes. Solution should positively affect CAPEX and OPEX per kWh and also be compliant with improving the water quality of the underlying water body and in particular positively affect biodiversity. Socio-economic and environmental sustainability including SDGs, circular economy, social, economic and environmental aspects should be addressed on a life cycle basis.

HORIZON-CL5-2024-D3-01-08: Demonstration of sustainable wave energy farms

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 18.00 and 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 38.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- De-risking wave energy technology development and increased bankability/insurability of wave energy.
- Increased availability and improved market confidence in the technology.
- Increased knowledge on positive and negative impacts of ocean energy on its environment and in the case of negative impacts to protected habitats and species proposals for necessary mitigation measures.
- Publicly available data collected from the demonstration/pilot structure including support structure.

Scope: Demonstration of sustainable wave energy pilot farms (minimum 2.0 MW installed capacity and at least 4 devices) in full operational conditions for long periods of time is essential to advance this sector. It is the way to bridge the gap from technology development

to market development while reducing costs, reducing risks and attracting investors for future commercial projects. The farms should be composed of several devices of the same type.

The wave energy farms have to be connected to the electricity grid. To focus on the technologies with the greatest chances of success, the single wave energy device to be used in the array deployment is expected to be satisfactorily demonstrated at full scale before, with limited changes to incorporate the learnings. Any change on the wave energy device may be incremental but should not involve fundamental changes to the device design or composition. The innovation component should mainly lie on the pilot farm systems and supporting industrial manufacturing activities that enable a cost-effective and high-performance pilot farm. Where established, stage-gate processes can help ensure that this approach is followed.

The project is expected to deploy a wave energy farm with a minimum capacity of 2 MW and operate the farm at least 2 years in the lifetime of the project. After the project it is expected that the farm will continue to be operated for at least 8 years. The project should develop and execute an effective operation and maintenance programme.

Proposals are expected to address also all the following for both the supporting infrastructure for the farm and for the individual devices themselves:

- Industrial design and manufacturing processes including set up of an industrial supply chain, circularity of (critical) raw materials, sustainability, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.
- Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Necessary mitigation measures should be integrated to protect habitats and species. Present an environmental monitoring plan to be implemented during the demonstration action. Environmental monitoring data should be open source and be shared with EMODNET and the IEA OES environmental task.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project. The project proposal is expected to present a clear and convincing pathway to obtaining necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. For this the use of other EU/national/regional support mechanisms can be considered. Independent experts will assess all deliverables and will advise for the go/no-go decision.

The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Data from the pilot structures should be collected to understand the performance and behaviour of the structure and the surrounding environmental condition to optimise the concept and understand the environmental impact of wave energy harvesting.

The selected projects are expected to contribute to the BRIDGE initiative¹⁸⁸, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2024-D3-01-09: Africa-EU CO-FUND action

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Programme Co-fund Action
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>The following additional eligibility criteria apply:</p> <p>In addition to the standard eligibility criteria, at least 40% of the partners must be from Africa Union member states.</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 50% of the eligible costs.</p> <p>Beneficiaries may provide financial support to third parties in the form of grants. Financial support provided by the participants to third parties is one of the primary activities of this action to allow the partnership to achieve its objectives. Therefore, the EUR 60 000 threshold provided for in Article 204 (a) of the Financial Regulation No 2018/1046 does not apply.</p>

¹⁸⁸ <https://www.h2020-bridge.eu/>

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Strengthening of the joint EU-AU Climate Change and Sustainable Energy Collaborative Partnership efforts, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.
- Acceleration of the achievements of the African continent's targets of the Paris Agreement.
- Establishing technologies for a sustainable energy system that meets the needs of different parts of society, in different geographical locations (urban and rural) and different economic sectors.

Scope: Following the EU commitments under the Paris Agreement, Agenda 2030 on Sustainable Development and the post-Cotonou Agreement, the renewed objective to evolve current forms of cooperation into equal footing partnership between Africa and Europe, the current research and innovation cooperation between Europe and Africa in the field of renewable energy needs to be further strengthened and developed.

The action should contribute to the implementation of the strategic and joint research and innovation action roadmaps¹⁸⁹ 1] implemented under Pilar 1 of the project LEAP-RE, www.leap-re.eu. The range of activities supported are expected to address the broad range of elements and technologies identified in LEAP-RE, in particular its six multi-annual roadmaps and should include a well-balanced set of research projects, demonstration projects, and technology transfer projects. Inclusiveness of a broad range of MSs/ACs and African partners will be considered an asset.

The proposal should envisage clustering activities with other relevant on-going EU-funded projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues. Synergy is also to be considered with the projects to be funded by the end of 2022 through the Joint Undertaking Clean Hydrogen topic HORIZON-JTI-CLEANH2-2022-05-05? "Research & Innovation co-operation with Africa on hydrogen". To this end, proposals should provide for a work package and/or task dedicated to clustering activities and earmark the appropriate resources accordingly. The clustering activities should also consider and implement a joint programme of activities focussed on communication (participation in joint meetings and communication events), dissemination and exploitation.

It is expected that the action will organise joint calls on an annual basis and will consider ample time for the implementation and closure of the co-funded projects.

The proposal should also provide support to the operation of the Climate Change and Sustainable Energy collaborative action of the AU-EU High Level Policy Dialogue on Science, Technology and Innovation.

¹⁸⁹ The roadmaps are available here www.leap-re.eu/pillar-1/

HORIZON-CL5-2024-D3-01-10: Next generation of renewable energy technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 27.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Available breakthrough and game changing renewable energy technologies enabling a faster transition to a net-zero greenhouse gas emissions EU economy by 2050.
- Knowledge and scientific proofs of the technological feasibility of the concept including the environmental, social and economic benefits to contribute to R&I strategy and policy forecast.
- Establishing a solid long term dependable European innovation base.

Scope: The proposal is expected to address high-risk/high return technology developments for game changing renewable energy technologies. It could cover catalyst development, dedicated renewable energy storage systems, integration of renewable energy technologies into a single energy generation system, heating & cooling systems, fuels production systems, solar driven chemical processes, hybrid electricity generation solutions between different renewable energy sources, direct utilization of renewable energy sources.

The following areas are excluded from the scope of the topic as they fall within the scope of partnerships or other calls:

- Hydrogen production through electrolyzers.
- Fuel cells.

- Material research is covered under cluster 4 topics.
- Batteries as being covered in Destination 2.

The proposal is expected to validate its concept to TRL 3 or TRL 4 through a robust research methodology and activities. It should establish the technological feasibility of its concept, consider transfer developments in sectors other than energy whenever relevant, as they may provide ideas, experiences, technology contributions, knowledge, new approaches, innovative adapted materials for energy and skills.

Whenever the direct use of biogenic waste is considered, it will be taken into account from the design stage.

In developing its concept, the proposal is expected to address the following related aspects: lower environmental impact, minimising the impacts on biodiversity and protected species and habitats, better resource efficiency (materials, geographical footprints, water, etc...), issues related to social acceptability or resistance to new energy technologies, related socioeconomic and livelihood issues. Comparison with current commercial renewable energy technologies and/or solutions is expected. Impacts will be assessed through a quantified based Life Cycle Analysis. Considerations should be given to the regulatory frameworks for their adequate integration.

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-01-11: AI Testing and Experimentation Facility (TEF) for the energy sector – bringing technology to the market

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
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Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Large-scale reference testing and experimentation facilities (TEFs) will offer a combination of physical and virtual facilities, in which technology providers can get support to test their latest AI-based software and hardware technologies in operational environments.
- This will include support for full integration, testing and experimentation of latest AI-based technologies to solve issues/improve solutions in the **energy sector**, at national as well as at local level, including validation and demonstration.
- The TEF is open to all the sites in Europe and equipped with the right equipment (Infrastructure, computing capacity & latest AI innovations).
- The TEF is a “long term investment”. There should be a business model to guarantee self-sustainability.

Scope: The TEF is a technology infrastructure that has specific expertise and experience with testing in real conditions in the energy sector. They should build on existing infrastructures, facilities.

TEF should become common resources open to all the players, especially end users who should closely be involved. TEFs seek to support technology providers, but we also expect TEFs to include end-users of the technologies to ensure co-creation (in particular end-users can be involved in defining testing scenarios, protocols and metrics).

The TEF has the scope to then bridge the gap between lab and market due to lack of in-depth testing of AI technology in the real environment to fully validate them before the deployment.

Energy AI TEF will aim at testing AI-based technologies and solutions that have already been tested in the labs and have to be tested in operational environments.

Energy AI TEF will aim at optimising the deployment of AI-based solutions for a greener, smarter, more resilient, and more flexible energy system. For instance, it can investigate, how electricity grids respond to stimuli or shocks (e.g. RES integration, cyber-attacks, micro-grids development), making use of digital twins of the electricity grid at local level. Energy AI TEF can also target distribution grid optimisation, integrating both (decentralised) supply and demand-side, taking into account energy data coming from buildings, local storage, DER, electrical vehicles

TEFs can also support regulatory sandboxes by setting up a dialogue with competent national authorities for supervised testing and experimentation under real or close to real conditions.

The TEF can also support the development of new standards and ontologies for AI-Software for energy sector and common interoperability framework.

Energy AI TEF should give regions a further boost in attracting funding to upgrade its facilities and also attracting innovative players to collaborate with its own champions. In addition, TEF will contribute to more trustworthy AI made in Europe.

HORIZON-CL5-2024-D3-01-12: Energy Management Systems for flexibility services

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Contribute to the use of smart buildings and smart industrial sites for the integration of renewables in the energy system in an efficient way.
- Demonstrate aggregation of multiple (building or industrial) energy management systems to provide flexibility services (wholesale market price signals, demand response, flexible production, smart charging, balancing & frequency services, congestion management) to the electricity network.
- Demonstrate interoperability and data exchange technologies to aggregate data from different sources and in different formats through cooperation between aggregators and energy management system developers.
- Piloting and demonstration of flexibility pool operations at the local and regional levels.

The selected projects should propose recommendations how current products, markets and market processes for flexibility should be adapted to accommodate these new services and/or fully benefit from the potential these improved energy management services will bring.

Scope: Projects are expected to:

- Develop solutions to aggregate flexibility from different (types of) energy consumers that use different energy management systems to develop interoperable solutions to optimise the energy management systems and valorise its flexibility in wholesale markets and for balancing and/or congestion management services).
- Define and demonstrate the type of flexibility services that clusters of smart buildings and smart industrial sites can provide.
- Cooperate with (one or more) TSOs and/or DSOs, preferably making use of day-to-day operational flexibility markets (i.e. not R&I projects or regulatory sandboxes).
- Include at least 3 different energy management systems in case of industry, or 5 in case of buildings, developed by different technology providers and that use different protocols/standards/proprietary solutions for the energy management system.
- Involve at least 3 different energy system management service companies in case of industry, or 5 in case of buildings.
- Include at least 2 aggregators to ensure that developed solutions are based on standards and to avoid proprietary solutions.
- Include at least 1 home appliances producer in case of buildings. To ensure interoperability and integration into the grid, specific demonstrators will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing Horizon 2020, Horizon Europe as well as under other EU programs such as the Digital Europe Program. Preferably semantically interoperable interactions, as enabled by the ETSI SAREF ontologies, are used.

Design and demonstrate appropriate concepts for acquiring and activating flexibility (implicit and explicit) that allow to maximally benefit from the potential of these new services. The project should demonstrate or recommend how the coordination and cooperation between TSO and DSO has to be organized to adopt the different concepts for services, products and markets.

The selected projects are expected to contribute to the BRIDGE initiative¹⁹⁰, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant

¹⁹⁰ <https://www.h2020-bridge.eu/>

activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2024-D3-01-13: DC and AC/DC hybrid transmission and distribution systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 13.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following outcomes:

- Demonstrated top-down electricity system orchestration of future pan-European AC / DC hybrid system architecture - including offshore grid and energy islands - at different voltage levels (HVDC, MVDC, LVDC) down to DC microgrids.
- Developed methodologies for operational planning and design of DC and AC / DC hybrid systems, considering all possible sources, loads and storage, from high-voltage transmission level to distribution-connected assets. This includes a cost benefit analysis for stability management options.
- Developed methodologies and requirements for interoperability among Multi Terminal, Multi-Vendor MVDC and LVDC systems.
- Demonstrated technologies to be applied to the energy system to address the gradual loss of inertia caused by the increasing penetration of Power Electronics Interfaced Generators (i.e., RES such as PV, Wind, etc.).
- Demonstrated DC transmission and distribution systems and technologies.
- Components and systems for smart substations.

- Close collaboration among the key grid stakeholders (non-exhaustive list: software developers, system manufacturers, TSOs, third-party system integrators, wind turbine manufacturers, offshore wind farm developers, PV plants, storage systems, etc.).

Scope: Projects are expected to implement the activities in (1) and the practical demonstration in (2) as described below:

1. R&I, methodologies and tools involving the activities in the three subtopics (A, B and C) listed below. These can be developed/complemented with others pertinent to each subtopic.

A) DC – AC / DC hybrid system Design & Planning

a. Demonstration of software tools for transnational AC/DC hybrid power system planning and management to enable HVAC/HVDC/MVDC/LVDC hybrid systems, such as:

- integration of multi-terminal HVDC systems, both offshore and onshore and HVDC links embedded within the HVAC network as well as HVDC ties (inter-) connecting different control zones and synchronous areas (in full or in back-to-back schemes);
- representation and modelling of transmission and distribution grids as well as multi-energy vector integration (sector coupling) for long-term and for transient and dynamic analysis.

b. Demonstration of reliability and resilience methodologies to address security and adequacy issues and criteria via not only deterministic but also probabilistic (e.g., Monte-Carlo) methods.

c. Demonstration of developed methodologies and requirements for interoperability among Multi Terminal, Multi-Vendor MVDC and LVDC systems.

B) AC and DC Grid Forming Capability

- Functional requirements and demonstration of grid forming capability for hybrid HV AC/DC networks (e.g., offshore wind, HVDC transmission or multi-terminal HVDC grid, potentially associated with energy storage systems).
- Functional requirements and demonstration of grid forming capability for hybrid MV and LV AC/DC networks (grid connected and islanded operation with distributed energy sources).
- Functional requirements and validation procedure for testing grid-forming capabilities offered by HVDC, MVDC and LVDC systems.

C) DC Distribution & microgrids

- Modelling (steady state and transient models) for systems including different typology of RES, EVs, storage and loads (system architecture, voltage level, control, stability, protection, and storage integration).

- Planning and design of MVDC distribution grids as the intermediate layer between the HVDC and the AC or DC Low Voltage local distribution grid and loads.
- Functional requirements for the AC-DC converters, DC-DC converters, switchgear (including protection equipment) and cables based on the different typologies and power rating applications

2. Demonstration, test and validation of the activities developed in (1) in at least three pilots – one for each sub-topic (A, B and C) – in different EU Member States/Associated Countries.

International cooperation with countries of the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-01-14: Condition & Health Monitoring in Power Electronics (PE) - Wide Band Gap PE for the energy sector

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 13.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following outcomes:

a. Condition and Health Monitoring:

- Capability to anticipate failures of Power Electronics (PE) in wind farms and converters of the DC grid to prevent downtime.
- Techniques to set the equipment in limp mode to enable to withstand the stress until next maintenance.
- Demonstration of Condition and Health Monitoring (C&HM) for converters of wind turbines generators and HVDC converter stations or MVDC converters (solar energy).

b. Wide Band Gap and Ultra-Wide Bandgap PE:

- Development of new semiconductor power device technologies, in particular Wide Bandgap (WBG) and ultra-wide Bandgap (UWBG) semiconductors
- Availability of more efficient Power Electronics components for the development of new generation of inverters, converters and other power equipment in the energy sector.
- Reduced space occupancy aiming mainly at offshore applications.
- Improved cost efficiency of power devices and semiconductor fabrication processes.

Scope: Projects are expected to implement both the activities in (1) and the practical demonstration (2) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to each sub-topic.

A. Condition and Health Monitoring (C&HM):

- Estimation of junction temperature T_j based on TSEPs (thermo-sensitive electrical parameters). Here especially big challenge present SiC MOSFETS and Schottky diodes because the TSEPs sensitivity is lower, non-linear and depends on the built technology. Further issues are calibration, circuit drift, influence of PWM and other.
- Development of new and evaluation/further development of already existing unconventional techniques to measure temperature and estimate degradation (such as for example, but not limited to, Kelvin connection or acoustic based methods).
- Development and evaluation of new or already existing techniques for generating the lifetime models based on big-data analysis and by utilisation of soft computing techniques.
- Combination of (big) data-driven and physics-of-failure driven approaches in C&HM.

B. Stress Steering:

- Successful business case realisation requires co-operation and communication between different partners:
- Manufacturers of power electronics components (for example to integrate sometimes-necessary sensors).
- System designer (to provide access to the data such as measured load cycles and general mission profiles).
- Companies responsible for operation and maintenance of the systems. Currently those companies are especially for offshore wind parks developing their own C&HM systems, which are operating, based on sometimes-scarce available data.

- Optimisation is possible when already initial products would be designed to obtain data/measurements needed in C&HM. For power electronics modules, the most valuable data seems to be T_j (junction temperature):
- Careful estimation of the costs of maintenance for specified applications (it seems they are currently underestimated).
- Investigation of different costs models (e.g., the final costs for C&HM can be absorbed by the producers especially when it is also responsible for maintenance, or it can be transferred to the final user whenever the final user can provide safer and more reliable service).

C. Wide Band Gap and Ultra-Wide Bandgap PE:

Improvement of WBG and UWBG semiconductors for integration in HVDC and MVDC components. Work should focus on improving wide bandgap semiconductor devices, packaging and their integration in converter submodules:

- Improved WBG and UWBG power devices with better performance metrics, e.g., lower conduction losses, higher blocking voltage, better surge current capability, higher switching frequencies and better short-circuit capability.
- Advanced control circuits for WBG and UWBG based bridges.
- Improved packages featuring high-voltage insulation, high temperature operation, robustness, and low eddy currents.
- New submodule topologies for HVDC converters and/or new converter topologies for MVDC converters with WBG and UWBG semiconductors and better performance metrics, e.g., reduced losses, higher reliability, lower volume / weight, less costs.
- Implementing WBG and UWBG semiconductor devices for DC protection devices, e.g., DC breakers.
- Improved cost efficiency of components based on WBG semiconductors.

2. Demonstration, test and validation of the activities developed in (1) (A, B and C) in at least two pilots (all activities A, B and C developed for each pilot) in different EU Member States/Associated Countries.

HORIZON-CL5-2024-D3-01-15: HVAC, HVDC and High-Power cable systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 5.00 and 5.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

	selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹¹ .

Expected Outcome: Project results are expected to contribute to at least three of the following outcomes:

- High Voltage (HV), Extra High Voltage (EHV) or High Power/superconducting cable systems, including dynamic AC – DC cables.
- Development of not only better performing, but also more environmentally friendly materials for cable and accessory insulation.
- Improved tools for remote monitoring, repair and maintenance of equipment.
- Assessment of the feasibility of new cable system technologies.
- Increased reliability of HVDC or High-Power cable systems, through improved cable accessory design and/or ageing studies and/or use of cable condition monitoring techniques.

¹⁹¹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Reduced cost of HVDC or High-Power cables, which increases feasibility of implementation in smaller projects, reducing the visual impact and improves social acceptability compared to AC overhead lines.
- Reducing the environmental impact of HVDC or High-Power cable systems through use of component designs with smaller climate footprints such as gas-free accessories or through conversion and reuse of existing infrastructure to increase power transfer capacity.
- When power demand increases and the ampacity of the power line is reached, the replacement of HVAC overhead lines with HVDC or with High-Power cable systems can avoid building new lines or reinforcing the grid.
- Increased power transfer over the same corridor and same or smaller right of ways.
- Methodology development of the OHL conversion from AC to DC with minimal line outage
- Contribution to the emergence of standards for DC OHLs in Europe
- Benefits of power dense technology options and avoidance of grid reinforcement.

Scope: Projects are expected to implement at least three of the activities in (1) for one or more subtopics (A, B, C) or (2) for one or more subtopics (D, E, F) and the practical validation in (3) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to the topic.

A. Innovation in cable systems

- Development of new insulating materials for dry type accessories for high temperature and above 525 kV
- Optimisation of newly developed high electrical resistivity insulating materials for use above 525 kV in cable and/or accessories.
- Development of new network components with reduced environmental impact such as EHV/HV cables without lead, application of superconductors, AC, DC cables/gas insulated lines for voltages above 525 kV.
- Development of larger conductor cross sections.
- Development of smaller conductor cross sections and leveraging higher current superconductors - greater power density benefits.
- Increase of maximum insulation operating temperature, such as for high load urban areas where available space for power transfer is limited.

- Further improvement of different types of extruded insulation materials (e.g., AC, DC-XLPE, Polypropylene) cables, and render recyclability of the materials feasible by refining the procedure of separation of the many components of the cable – insulation, wires, tapes, sheaths, etc. – from each other. Establishment of procedures for recycling and related possible products.
- Feasibility study for use of superconducting cables for submarine connections to determine their environmental benefits e.g., extremely low heat emittance, since they do not emit any heat, zero magnetic field benefits to marine fauna, smaller cable corridors for higher power densities, smaller landfall space requirements, etc.
- Simulation and design of innovative dynamic cable systems to meet the needs of the growing floating offshore applications.

B. Predictive models for cable system ageing (fraction-of-life lost, remaining life), life and reliability

- Modelling of space charge phenomena (as well as other relevant phenomena) in newly developed insulating materials, in full size cables and accessories.
- Modelling of its effects on cable system aging taking advantage of advanced experimental space charge measurement techniques.
- AI methods for managing a cable fleet angle.
- Impact of water absorption on ageing of lead-free wet-design HVDC or High-Power cables.
- Ageing of cable systems, including effect of contaminants, humidity and temperature, and its implications for space charge accumulation and lifetime estimations. Test methods to quantify ageing in a DC environment, such as voltage form for DC-specific breakdown testing.

C. Monitoring and fault location systems

- Continuous temperature and acoustic monitoring of long cable system lengths.
- Accurate and instantaneous fault location systems for long cable system lengths.
- Further development and improvement of on- and off-line diagnostics and condition monitoring techniques for HVDC or High-Power cable systems such as PD and leakage current measurements for online and space charge and dielectric permittivity and loss factor measurements for offline.
- Innovative technological solutions such as fibre-based and/or robotic technologies for data collection and maintenance in in all type of location (easy-to-access and inhospitable).

- Development of procedures for optimised maintenance and repair concepts of offshore stations using BIM and 3D-Models.

2. Investigation and development of potential replacement of HVAC overhead lines with HVDC or High-Power cable solutions to increase capacity transfer without the need of building new infrastructures but reusing existing right of ways.

D. Cost-Benefit Analysis for different options of HVAC OHL conversion

- Mapping of the potential use cases for replacement of HVAC with HVDC or High-Power solutions (buried or overhead) supported by a Cost-Benefit Analysis.
- Cost-Benefit Analysis for conversion of HVAC OHL to HVDC, High Power OHL or buried High-Power cable solutions.
- Resilience and reliability analysis of different HVAC OHL conversion options – underground cable, HVDC OHL and buried High-Power cable solutions.

E. Technical innovations and design methodologies of hybrid HV AC/DC overhead lines

- Insulation coordination and clearances calculation methodologies, for HVDC and hybrid HV AC/DC overhead lines.
- Electrical field and ion current density calculation methodology under hybrid HV AC/DC OHLs ion flow field.
- Operation, control and protection of hybrid AC/DC overhead lines.
- Management of long-distance mixed cable and OHL HV corridors.

F. Pan-European grid studies and unification of voltage level of the converted OHLs from HVAC to HVDC

- Proposal of a unified DC voltage level of the converted lines considering the standard towers and line designs of HVAC OHLs (220 kV, 400kV) in the European network to provide a general conversion approach, compatible with minimum operation downtime.
- Perform pan-European grid studies to propose a unified strategy toward an overlaying HVDC grid based on the converted HVAC OHLs and existing corridors with minimized environmental impact, link downtime and implementation time.
- Dynamic grid studies to demonstrate the impact of the HVAC OHL conversion to HVDC.
- Develop identification criteria for the candidate HVAC OHL corridors (to be converted in HVDC).

3. Test and validation of the activities developed in (1) consisting of at least one of the activities described in each subtopic A, B, C or (2) consisting of at least one of the activities

described in each subtopic D, E, F in at least two validation tests in different EU Member States/Associated Countries.

HORIZON-CL5-2024-D3-01-16: Demonstration of innovative pumped storage equipment and tools in combination with innovative storage management systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased availability of innovative hydropower storage, in combination with innovative storage management systems.
- Maintain and increase technology leadership, competitiveness and technology export potential of European hydropower storage technology industry.
- Enhanced sustainability of innovative hydropower storage technologies, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- Reduced cost and improved efficiency of hydropower storage installations and the underlying technologies.

Scope: Demonstration of innovative pumped storage equipment and digital tools linking the mechanical storage with innovative storage management systems. The latter may involve hybridisation with storage technologies to reap the full potential of pumped hydro storage under new market conditions Solutions should deliver innovative hydropower technologies

adapted to unconventional storage schemes, including e.g. low-head locations or former coal mines and/or harsher operation conditions, e.g. using salt water, while minimising CAPEX, OPEX and improving life time and circularity of components. For the storage management system, digital tools for strategic and operational management should address current developments for energy storage, considering markets, variable renewable production and effects of climate change, and including novel approaches to energy. Demonstrated storage solutions should respond to the highest standards of environmental sustainability which is underpinned by a LCA and involve Citizens and Communities during all phases of the project activities, respectively. An analysis of innovative storage potential and impact should be performed.

Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, InvestEU, EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2024-D3-01-17: Development and integration of advanced software tools in SCADA systems for High, Medium and Low voltage AC/DC hybrid systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least three of the following outcomes:

- Optimised connection between power system design, preoperational planning and real-time monitoring and control.

- Measures and strategies for stability management of the future HVDC/MTDC power system connecting renewable energies (more specifically onshore wind farm).
- Measures and strategies for stability management of the future AC/DC hybrid power system with a high share of Power Electronic Interfaced Devices (PEID).
- Real-time capable algorithms and tools that enables optimal operation of the hybrid AC/DC system (e.g., avoidance of circular flows) and to support security analyses.
- Innovative ancillary services (e.g., frequency control, mitigation of periodic frequency fluctuations, voltage regulation and reactive power control).
- The possibilities offered by fast DC control in terms of islanding, black-start capability, firewalling for fault impact minimisation/avoidance, support for fault identification and return to safe, normal operation.
- Increased security of supply through firewalling cascading effects due to faults or cyberattacks by segmentation of the grid with a DC link.

Scope: Projects are expected to implement the activities in (1), the practical demonstration (2) and the recommendations for grid codes (3) for a realistic use case, at one or two voltage levels or at system level including all three voltage levels as described below:

1. Development of methodologies, technologies, algorithms and software tools, involving at least three of the activities listed below.
 - o Development of innovative technologies, algorithms and analysis modules for multi terminal HVDC system – Software tools for analysing stability compatibility between DC and AC power system (e.g., Grid forming Vs. DC voltage stability)
 - o Development of innovative algorithms and software tools for analysing and controlling the system of mixed, hybrid AC/DC grids. Integration of these tools into the control room software.
 - o Scalable and flexible software framework for operation of hybrid AC/DC power systems supporting various vendor-dependent systems and component models, e.g., more accurate and wider representation of connected systems, power flow calculations.
 - o Vendor independent hybrid DC/AC network SCADA/Energy Management System and upper-level control of voltage source converters (multi-vendor, multi-terminal), including changing active power set points, voltage/reactive power control set points and changing controller parameters.
 - o Development and management of small signal and dynamic stability in a hybrid AC/DC power system with high penetration of inverter-based resources.

- o Development of a robust online real-time estimation and calculation of the system state of the AC, DC and hybrid system.
 - o Development of safety and reliability analysis of the system state, analysis of possible failure situations as well as curative measures for the failure event, e.g., transient and dynamic stability, coordinated risk management.
 - o Development and integration of cyber secure resilient ICT platforms and communication for data exchange.
 - o Development of a DC link for firewalling the grid from cascading effects due to faults or cyberattacks.
2. Demonstration, test and validation of the activities developed in (1) for a fully automated decision support system for control centres in at least two pilots in different EU Member States/Associated Countries.
 3. Recommendations for changes in grid codes, which can facilitate the deployment of the technology and ensure the full exploitation of the assets.

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2024-D3-02

Conditions for the Call

Indicative budget(s)¹⁹²

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁹³	Indicative number of projects expected to be funded
		2024		
Opening: 17 Sep 2024 Deadline(s): 21 Jan 2025				
HORIZON-CL5-2024-D3-02-01	IA	6.00	Around 3.00	2

¹⁹² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

¹⁹³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL5-2024-D3-02-02	RIA	12.00	Around 4.00	3
HORIZON-CL5-2024-D3-02-03	RIA	7.00	Around 3.50	2
HORIZON-CL5-2024-D3-02-04	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-02-05	IA	14.00	Around 7.00	2
HORIZON-CL5-2024-D3-02-06	IA	10.00	Around 5.00	2
HORIZON-CL5-2024-D3-02-07	CSA	3.00	Around 3.00	1
HORIZON-CL5-2024-D3-02-08	RIA	10.00	Around 5.00	2
HORIZON-CL5-2024-D3-02-09	IA	30.00	Around 15.00	2
HORIZON-CL5-2024-D3-02-10	CSA	8.00	Around 2.00	4
HORIZON-CL5-2024-D3-02-11	IA	15.00	Around 7.00	2
HORIZON-CL5-2024-D3-02-12	IA	15.00	5.00 to 7.00	3
Overall indicative budget		138.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-02-01: Digital tools for CSP and solar thermal plants

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.
<i>Procedure</i>	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio, grants will be awarded to proposals not only in order of ranking but at least also to one proposal that is the highest ranked within the area of concentrated solar power (CSP) and at least also to one proposal that is the highest ranked within the area of solar thermal heat and/or cold, provided that proposals attain all thresholds.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹⁴ .
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Expected Outcome: Project results are expected to contribute to some of the following expected outcomes:

- Improved performance of concentrated solar power (CSP) plants.
- Improved performance of concentrated and/or non-concentrated solar thermal heat and/or cold plants.
- Reduced operation and maintenance costs of CSP plants.
- Reduced operation and maintenance costs of concentrated and/or non-concentrated solar thermal heat and/or cold plants.
- Reinforced role of CSP plants in the power market.
- Reduced greenhouse gas emissions.
- Achievement of the CSP targets of the Strategic Energy Technology Plan.

Scope: Support will be given to the innovative application of digital tools (or to the application of innovative digital tools, or both) in CSP and/or concentrated solar thermal heat and/or cold and/or non-concentrated solar thermal heat and/or cold plants. Any type of application of the digital tools is in the scope (e.g., component control, performance measurement, self-diagnostic, ancillary services to the power system, digital twins, etc.). Artificial intelligence techniques are also in the scope.

Proposals are expected to bring and demonstrate measurable benefits of the proposed digital tools in terms of operation, maintenance, and flexibility of the plant.

Where applicable, the digital tools should support night baseload generation from thermal energy storage.

Where applicable, the demonstration should span a continuous interval of at least six months covering all possible incidence angles of the direct solar radiation.

HORIZON-CL5-2024-D3-02-02: Development of next generation synthetic renewable fuel technologies

Specific conditions	
<i>Expected EU</i>	The Commission estimates that an EU contribution of around EUR 4.00

¹⁹⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

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<i>contribution per project</i>	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increase availability of disruptive emerging synthetic renewable fuel technologies.
- Accelerate the readiness of cost-effective and highly performing future technologies of synthetic renewable fuels for all economy sectors.
- Reinforce the European scientific basis and European technology export potential for synthetic renewable fuel technologies.

Scope: Development of next generation technologies for the production of novel synthetic renewable liquid and gaseous fuels from CO₂, and/or renewable carbon, nitrogen, hydrogen or their compounds and from renewable energy. Process energy will also be renewable. Synergies with other renewable energy technologies can be explored. Focus should be on the high source to product conversion efficiency, process energy efficiency and carbon emission neutrality from the overall production. Overall, proposals are expected to improve competitiveness and minimize GHG emissions in the production process. Pathways via production of renewable hydrogen or renewable hydrogen ionic compounds from all forms and origins of renewable energy (e.g., electricity, direct sunlight, heat) are in scope. The new technologies should also address uses in fuel cells for all transport modes for electricity generation from renewable fuels used as renewable energy carriers with high conversion efficiency and low pollution. An assessment of the sustainability and the GHG emissions should be made based on a Life Cycle Analysis.

Projects should collaborate if appropriate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

HORIZON-CL5-2024-D3-02-03: Development of smart concepts of integrated energy driven bio-refineries for co-production of advanced biofuels, bio-chemicals and biomaterials

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 7.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Expand the portfolio of cost-effective advanced biofuel production concepts through energy-driven biorefineries.
- Reduce cost, improve efficiency, support de-risking, to accelerate the availability of competitive and zero-waste advanced biofuel production concepts.
- Contribute to the Mission Innovation 2.0 mission of Integrated Biorefineries.
- Optimize resource efficiency, energy output and total products value from biomass
- Reinforce the European scientific basis and European export potential for renewable fuel production solutions through international collaborations.

Scope: Development of zero-waste and neutral or negative carbon emission energy-efficient biorefinery concepts for enabling the production of low-cost advanced biofuels through co-production of added value bio-based products and bioenergy. Conversion of biogenic wastes and residues as well as algae and aquatic biomass through chemical, biochemical, electrochemical, biological, thermochemical pathways or combinations of them in highly circular processes are in scope. The integration design is expected to include mass and energy

flows, addressing the process heat and power needs by the use of co-produced bio-heat and bio-power, capturing and reusing biogenic effluent gases and sequestering biogenic emissions, for example in the form of biochar as soil amendment, such as to maximize overall material and energy efficiencies. An assessment of the feedstock cost supply at regional and local level and improvement of feedstock mobilisation patterns including via enabling technologies, such as digitalisation, should be included. Socioeconomic and environmental sustainability including circular economy, social, economic and environmental aspects are expected to be assessed on a life-cycle analysis basis. The advanced biofuels cost should aim to be reduced at parity with marketed biofuel equivalents or in the absence of these competitive to the fossil fuel equivalents. Technology validated in relevant environment is required. International cooperation with Mission Innovation countries is expected. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate.

Synergies are possible with topic HORIZON-CL6-2023-ZEROPOLLUTION: Innovative technologies for zero pollution, zero-waste biorefineries (RIA) and respective cooperation activities are encouraged.

HORIZON-CL5-2024-D3-02-04: Critical technologies for the future ocean energy farms

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased performance of ocean energy technologies with the focus on sustainability, operation and maintenance of ocean energy devices.

- Improved knowledge on how to operate ocean energy devices, their availability, maintainability, reliability, survivability, and sustainability.
- Reduction of LCOE.

Scope: Projects are expected to address at least one of the following areas:

1. Components and systems used in ocean energy devices need to be resistant to corrosion and the heavy loads they are subject to. Develop new sustainable materials with improved fatigue, damping, stiffness, sustainability and bio-fouling management or other cost-reducing characteristics. Materials such as reinforced concrete, polymers, composites, and concrete-steel/composite-steel hybrids systems have demonstrated some advantages such as reduced costs. Demonstrating the potential benefits of these new sustainable materials in ocean energy converters, moorings and foundations whilst ensuring structural integrity, durability and circularity is required. Advance the design of sustainable tailored mooring and connection of electrical or other power transmission systems for floating or subsea wave and tidal devices. Advance combined mooring and electrical connectors or hydraulic power transmission to reduce component cost and number of connection operations, included in systems for sharing an anchor between devices in arrays. Develop novel systems for safe and quick connection/disconnection that do not require large vessels and/or diving teams.
2. Instrumentation for condition monitoring and predictive maintenance of ocean energy devices. Apply recent advances in condition and structural health monitoring from other sectors to ocean energy – particularly those currently developed for offshore wind. Apply latest sensor technology to existing ocean energy deployments. Document and share experience on sensors performance and reliability, and methods for adapting them to the harsh ocean energy environment. Improve transmission or storage of data collected from sensors, such as underwater data transmission.
3. Artificial Intelligence (AI) in ocean energy technology development. Develop or apply advanced simulation of ocean energy systems. Use of big data with analysis of data streams, application of big data methods and machine learning, including artificial intelligence, or digital twin models for the design, installation, operation and decommissioning of ocean energy devices.

Improvements in the discrete technology areas should be developed holistically – e.g. work on monitoring instrumentation should be consistent with work on moorings & connections. The innovative technologies should not significantly harm the environment (DNSH principle), and have low impact on ecosystem biodiversity and consider potential mitigation measures. The projects should by using the precautionary principle elaborate proposals for acceptable harm and what low impact on biodiversity mean.

It is expected that key performance indicators are used based on international recognized metrics

Projects should demonstrate how improvements in the different technology topics can be applied to multiple different ocean energy devices – for example to a wide range of floating devices, or a wide range of sub-sea devices.

HORIZON-CL5-2024-D3-02-05: PV-integrated electric mobility applications

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal to a clean energy system and the achievement of the net zero-emissions target. To this end, it is important to enhance affordability, sustainability and exploit the modularity and synergies of application of PV technologies.

Consequently, project results are expected to contribute to all of the following expected outcomes:

1. Open new market opportunities for Vehicle-Integrated Photovoltaics (VIPV) in road transport.
2. Reduce usage of the electricity grid and increase the range of electric vehicles.
3. Cost and energy efficient climate-neutral road transport.

Scope: PV technology can contribute to improved features of electric mobility systems not just in terms of CO₂ (and air-pollution) emissions reduction but also regarding product aesthetics and user experiences. Proposals are expected to:

1. Demonstrate Vehicle Integrated PV concepts (VIPV),
 - a. Including different cell, interconnection and encapsulation technologies (with high efficiency under lower and varying lighting conditions) having a flexible design (size, shape/curvature, lightweight, aesthetics) and antifouling property, with PV providing a significant part of the vehicle’s energy consumption under various climatic conditions.
 - b. Considering cost optimisation and environmental friendliness of VIPV integration that meets automotive specifications and safety/repair/maintenance standards (crash, emergency, resistance, reliability, long-lasting lifetime and high number of lifecycles) for various types and vehicle uses (including the provision of grid services);
 - c. With a vehicle usage model that maximises the ratio of using solar power and performance for VIPV, considering various light intensity variations, climatic conditions and uses while minimising energy losses.
 - d. Involving multidisciplinary consortia including at least one vehicle manufacturer.
2. Demonstrate PV Charging Stations (EVs, electric buses, etc.) able to provide a significant part of the charging demand despite the PV intermittence, guarantee the balance of the public grid, and reduce the public grid energy cost, with optimal charging/discharging start time for EVs, through its arrival time, departure time, initial and final state of charge (SOC), to achieve peak shaving, valley filling and other types of grid services, while reducing the costs of energy from the public grid.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2024-D3-02-06: Innovative, Community-Integrated PV systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: PV is growing fast, from domestic and commercial, up to utility scale systems. In the years ahead PV systems and solutions will be an integral contributor of distributed generation, pivotal in building functional energy communities, aggregated and operated through advance distributed controls in hierarchical set up with the integrated grid. Project results are expected to contribute to all of the following expected outcomes:

- Increase the profitability and penetration of PV systems in renewable energy communities.
- Engage actively citizens and communities in the clean energy transition in particular through the uptake of energy cooperatives and the development of decentralized platforms.

Scope: Proposals are expected to demonstrate a community-aggregated system with a portfolio of producers and users to facilitate the energy transition to a low carbon economy. Through this approach solutions can effectively address the need for overcoming energy poverty, support energy democracy, and expand cooperative solutions for the collective benefit of providers and users. Peer to peer trading and use can be made feasible and emerging solutions highly attractive and implementable.

- Planning, plant optimisation tools, advanced installation criteria, construction issues to increase yield and thus economic performance of PV systems in the built environment.
- Implementation of collective self-consumption schemes, design, simulation, integration with storage, interaction with electric mobility and interaction with the electrical grid to provide power flexibility.
- Effective protocols and robust communication and cooperation between the various required levels of control that is cyber secure, offering the benefits of advanced smart power electronics, sensors and intelligent systems.

This topic requires the effective contribution of Social Science and Humanities (SSH) disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. Social innovations should also be considered, notably as new tools, ideas and methods leading to active citizen engagement and as drivers of social change, social ownership, and new social practices.

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-02-07: Resource Efficiency of PV in Production, Use and Disposal

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 3.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹⁵ .

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important

¹⁹⁵ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

to enhance its sustainability while creating wealth and additional employment opportunities in Europe.

Consequently, project results are expected to contribute to all of the following outcomes:

- Reduce the environmental footprint associated to PV technology deployment across all the phases of the system lifetime (production, transport, installation and end of life).
- Define design and processing guidelines to optimally address circularity of PV systems for one or several PV technologies (silicon, thin film, organic PV, perovskite PV, etc.).

Scope: In order to identify the main areas of improvement for the environmental footprint and resource efficiency of PV, it is necessary to regard the technology’s entire lifecycle. Using Life Cycle Assessment (LCA), important knowledge can be gained as to which processes and materials contribute most to the overall environmental footprint. The lifecycle-thinking also aids in identifying key candidates to reduce the use of resources from the design phase. Although it seems self-explanatory that reduction/substitution or efficient use of critical materials lead to improved environmental impact, it is of course essential that these do not adversely affect the function of the technology.

For a renewable energy technology to be successful, it needs to have a strong net positive energy balance. This implies that the energy payback time of systems needs to be short, the carbon footprint needs to be reduced, the use of local materials to reduce transport costs in systems needs to be increased, the use of hazardous materials needs to be avoided, and systems and system components need to be designed in a way that encourages recycling and decreases material usage.

Modern eco-friendly technologies and long lasting, repairable products are required in combination with sound circular economy approaches to process the huge stock of valuable resources at the end of life.

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-02-08: Minimisation of environmental, and optimisation of socio-economic impacts in the deployment, operation and decommissioning of offshore wind farms

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions

<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹⁶ .

Expected Outcome: If the project is on the first action 1) than the project results are expected to contribute to at least three of the outcomes a), b), and c). If the project is on the second action 2) than the project results is expected to contribute at least two of the outcomes a), b) and d)

- Enhanced sustainability by addressing economic, social and environmental aspects (air pollution, waste management, health and safety, job opportunities, wildlife concerns, etc.) of offshore wind farms (a).
- Enhanced overall sustainability of large-scale production of offshore wind farms based on mainstreamed Life Cycle Analysis addressing social, economic and environmental aspects, as well as improved circularity of offshore wind turbines (b).
- Improved understanding on the negative and positive impacts of offshore wind farms throughout their lifetime (c).
- Innovative and cost-effective solutions for the construction and decommissioning of offshore wind farms aiming also the minimisation of the potential impacts to biodiversity and protected species and habitats (d).

Scope: The aim is to develop and promote the use of modelling tools and objective holistic assessment metrics for realistic in-depth analysis of (cumulative) impacts of wind installations on the environment and on local communities and to integrate these in design tools for the

¹⁹⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

deployment and decommissioning of offshore wind farms. It will be as well necessary to find innovative solutions to minimize the environmental impact during all stages of the life cycle of offshore wind farms but especially for the construction and decommissioning phase. An assessment framework for installations is needed with nature inclusive design options valuing ‘created habitats’ vs ‘natural habitats’.

The actions are expected to address one of the following actions:

Action 1: develop design tools which can be used for the planning of offshore floating and fixed-bottom wind farms with the focus to minimize the overall life-cycle environmental impacts (noise, impact on seabed, visual effect, effects on marine life and other species) including floating turbines (e.g. the environmental impacts of fixing/anchoring techniques), reducing carbon footprint of the offshore wind plants across the life cycle, from construction to end of life and reduce the environmental impact in each consecutive step. The tool should make use of existing data of environmental impact studies and should be easy to customise considering different sea basin biodiversity characteristics and new available data. For that reason, a strong participation/commitment of industry players is required to ensure that inventory data from industry of the components is used in the analyses and validation of the tools. The action will deliver recommendations for implementable, simple and measurable criteria to assess at the tendering stage of future project, considering the sustainability and environmental (positive and negative) impacts of offshore wind farms.

Action 2) develop innovative and cost-effective solutions (innovative processes, planning processes, supply chains, materials for construction, ...) for all phases of the life cycle of offshore wind farms but especially for the installation, construction and decommissioning phase of offshore wind farms with the aim to reduce the environmental impact as much as possible in these stages of the life cycle of offshore wind farms.

In order to increase the integration of the design tools and the innovative solutions, it is important that consortia engage all different stakeholders like regulatory bodies, industry, governments and citizens.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to ‘carry out an analysis of costs and impacts of the decommissioning of offshore installations, with a view to assessing whether, both for the dismantling of the existing installations and for future decommissioning activities, EU-wide legal requirements are needed to minimise environmental, safety, economic impacts’.

HORIZON-CL5-2024-D3-02-09: Demonstrations of innovative floating wind concepts

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 30.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased knowledge about design, construction, assembly and operation and maintenance of floating wind farms.
- Improved overall constructability, reliability, installability, operability and maintainability of floating offshore wind systems.
- Demonstrated efficient, low-cost and sustainable emerging technologies for floating wind turbines; reduction of the LCoE.
- Reinforced European offshore wind turbine value chain and skills.
- Data for future optimisation of industry scale commissioning of the floater, mooring and anchor system.

Scope: The overall aim is to accelerate the cost-effective construction and deployment of floating wind farms, facilitating their rapid and sustainable deployment across Europe and lower their overall costs. Projects are expected to

1. Do the design optimisation of a full floating system, facilitate the execution of the project addressing space needs in ports, vessels, etc., supply chain development
2. Demonstrate innovative floating vertical or horizontal axis offshore wind energy platforms (4 MW or higher total capacity for horizontal and 2 MW or more for vertical axis) in real sea conditions for long periods of time (12-24 months), collect data for future improvement design of the concept, to accurately predict future floating wind energy production and providing valuable learnings regarding performance, reliability, availability, maintainability, survivability and environmental impact. The wind energy system should be grid connected.
3. Develop and implement pilot projects for floating wind by identifying the best existing practices and the remaining knowledge gaps.

Proposals are expected to address also industrial design and manufacturing processes, circularity of (critical) raw materials, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.

Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Present an environmental monitoring plan to be implemented during the demonstration action. Data on environmental monitoring have to be shared with EMODNET, the IEA Wind Task 34 on the Environmental Impact of Wind Energy Projects, IEA Wind Task 49 on Floating Offshore Wind and IEA OES Environmental Task 4.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project and a plan to achieve certification by an independent certification body before the end of the action. The project proposal is expected to clearly demonstrate a proposed pathway to obtaining necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. Independent experts will assess all deliverables and will advise for the go/no-go decision.

Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

The selected projects are expected to contribute to the BRIDGE initiative¹⁹⁷, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to ‘develop new wind, ocean energy and solar floating technology designs, for example through Horizon Europe’.

HORIZON-CL5-2024-D3-02-10: Market Uptake Measures of renewable energy systems

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately.

¹⁹⁷ <https://www.h2020-bridge.eu/>

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<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹⁸ .

Expected Outcome: Project results are expected to contribute to at least two of the following expected outcomes:

- Facilitate the wider uptake of renewable energy systems (RES) in the energy, industrial and residential sectors leading to an increased share of renewable energy in the final energy consumption by 2030 and beyond.
- Contribute to provide open source validated tools and methodologies for policy makers and stakeholders for developing more informed RES policy and for analysing the market dynamics when including all renewable energies.
- Contribute to the development of markets and respective financial frameworks that can operate in an efficiently and incentive-compatible manner while accommodating massive shares of renewables.
- Improve social acceptability of renewable energy facilities and installations.

Scope: The proposal is expected to develop solutions addressing at least 2 of the expected outcomes either for the entire renewable energy market or focusing on a specific energy

¹⁹⁸ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

sector, such as electricity, heating, cooling or renewable fuels. Proposals can also address issues within a specific geographical region such as urban and peri-urban areas. Issues related to acceptability of RES technologies due to ecologic, economic and social aspects are expected to be addressed. Self-consumption issues can be addressed too. International aspects, such as collaboration with third countries and promoting solution in new markets, can be addressed as well.

The proposed solution can be developed to address a local challenge but needs to have wide potential for reapplication. The solution is expected to have a long-term viability and not be limited to an ad-hoc fix. The methodologies applied may be inspired by successful approaches already tested in other fields or contexts.

For all actions, the consortia have to involve relevant stakeholders (e.g. businesses, public authorities, civil society organisations) and market actors who are committed to adopting/implementing the results. The complexity of these challenges and of the related market uptake barriers may call for multi-disciplinary approaches, which requires contributions from the social sciences and humanities. Where relevant, local, regional specificities, socio-economic, gender-related, spatial and environmental aspects will be considered from a life-cycle perspective.

Proposals are encouraged to address social acceptability through the assessment of the environmental economic and social impacts associated with the development of these renewable energies and through the adequate involvement of stakeholders in decision-making processes.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects for understanding and addressing societal barriers to the uptake of renewable energy systems.

Where relevant, proposals are expected to also assess the legal, institutional, and political frameworks at local, national and European level and examine how, why and under what conditions these could act as a barrier or an enabler.

Carbon Capture, Utilization and Storage (CCUS)

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-02-11: CCU for the production of fuels

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ¹⁹⁹ .

Expected Outcome: Conversion of captured CO₂ is not only a means to replace fossil fuels, but also a promising solution for seasonal energy storage. There are still some scientific and technological challenges to overcome to be able to exploit CO₂ as a fuel feedstock, the main challenge being that the utilisation of CO₂ is limited by the highly energy intensive conversion process.

New solutions for the conversion of captured CO₂ from different sources to fuels will create new markets for innovative industrial sectors and diversify the economic base in carbon-intensive regions, as well as contribute to achieving a Circular Economy. The project should evaluate the possibility for industrial CO₂ use/reuse through the combination of processes (industrial symbiosis) and the efficient integration of CO₂ capture and conversion to combine and/or reduce stages.

Scope: Proposals will aim at the development of energy-efficient and economically and environmentally viable CO₂ conversion technologies, including energy storage and/or displacement of fossil fuels that allow for upscaling in the short to medium term. Proposals have to define ambitious but achievable targets for energy requirements of the conversion process (including catalytic conversion), production costs and product yields that will be used to monitor project implementation. Proposals have to include the potential for the proposed

¹⁹⁹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

CCU solution(s) as CO₂ mitigation option through conducting an LCA (Life Cycle Assessment) in line with guidelines developed by the Commission, such as the Innovation Fund GHG methodology and the relevant ISO standards and the EU Taxonomy Regulation.

Technology development has to be balanced by an assessment of the societal readiness towards the proposed innovations. Relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) will be identified in the proposal, and involved in deliberative activities, so as understand and address their concerns and needs. This will be analysed during the project using appropriate techniques and methods from the social sciences and humanities, in order to create awareness, gain feedback on societal impact and advancing society's readiness for the proposed solutions. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities. Projects should also explore the socio-economic and political barriers to acceptability and awareness with a view to regulatory or policy initiatives and include aspects of circularity and best use of resources.

Proposals are expected to bring technologies that have reached at least TRL 4-5 to TRL 6-7 (please see part G of the General Annexes).

Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects are strongly encouraged to join the EU CCUS knowledge sharing project network.

Projects should collaborate if appropriate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

This topic is complementary to the call CL4- Destination 1 Energy Intensive Industries on CCU.

HORIZON-CL5-2024-D3-02-12: DACCS and BECCS for CO₂ removal/negative emissions

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.

<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Procedure</i>	The procedure is described in General Annex F. The following exceptions apply: In order to ensure that a balanced portfolio of activities covering both DACCS and BECCS, the available budget will first be allocated to the proposal with the highest score, followed by the next highest-ranked proposal dealing with the technology that has not been covered by the proposal selected first.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁰⁰ .

Expected Outcome: The European Union aims at reducing its net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, and at achieving carbon neutrality by 2050. Under the European Green Deal, the Commission has also adopted a zero-pollution action plan, with a zero-pollution ambition, and a Biodiversity Strategy. In view of achieving these ambitious targets it is appropriate to further explore the development of direct air carbon capture and storage (DACCS) and bioenergy carbon capture and storage (BECCS) as CO₂ capture technologies in combination with CO₂ storage, duly assessing their impacts on other environmental challenges.

The project is expected to develop highly innovative CCUS /carbon negative technologies leading to CO₂ removal. It should enable the cost-effective deployment of technologies such

²⁰⁰ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

as (DACCS), (BECCS) ideally linking them to industrial clusters with special emphasis of these technologies to safe CO₂ underground storage and CO₂ utilisation.

Project results are expected to contribute to at least one of the following expected outcomes:

- Improve existing or develop new materials for DACCS and/or BECCS technologies; or
- Address potential barriers to the incorporation of DACCS and/or BECCS technologies in existing CC(U)(S) concepts; or
- Make DACCS and/or BECCS technologies a viable option to make the EU carbon neutral by increasing the TRL levels and reducing cost of the different technological options

Scope: This topic focusses on DACCS and BECCS, which are technologies that can help reaching climate neutrality by 2050 by creating the carbon sinks required to balance out residual emissions in 2050.

The scope of this topic is to further the technological development of DACCS and BECCS, and addressing the environmental, social and economic challenges and benefits with the view of establishing this concept as a viable technology to fight climate change. The potential technologies require major technological breakthroughs.

Projects have to substantiate the potential for the proposed solutions as CO₂ mitigation option by conducting an LCA in conformity with guidelines developed by the Commission, such as the Innovation Fund GHG methodology and the relevant ISO standards and the EU Taxonomy Regulation. This life cycle consideration should include the sustainability of biomass and the renewable origin of electricity but also assess other environmental dimensions (requirements for land, water; impacts on air and water quality, biodiversity; distances to major storage clusters, leakages etc.).

Technology development has to be balanced by an assessment of the societal readiness towards the proposed innovations. Relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) will be identified in the proposal and involved in deliberative activities to understand and address their concerns and needs. This will be analysed during the project using appropriate techniques and methods from the social sciences and humanities, in order to create awareness, gain feedback on societal impact and advancing society's readiness for the proposed solutions. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities. Projects should also explore the socio-economic and political barriers to acceptability and awareness with a view to regulatory or policy initiatives and include aspects of circularity and best use of resources.

Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial

model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals that include research into the use of direct air capture and BECCS for enhanced oil recovery will not be considered. Proposals are expected to take into account the related activities within the EU ETS Innovation Fund and the EU Catalyst Partnership. International cooperation with Mission Innovation countries is encouraged in line with the Carbon Dioxide Removal Mission (CDR Mission).²⁰¹.

Successful projects will be encouraged to join the EU CCUS knowledge sharing project network.

²⁰¹ Applicants are reminded that legal entities established in China are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.

Destination – Efficient, sustainable and inclusive energy use

This Destination addresses activities targeting the energy demand side, notably a more efficient use of energy as regards buildings and industry. It contributes to the activities of the Strategic Energy Technology Plan (SET Plan) and its implementation working groups.

This Destination contributes to the following Strategic Plan’s **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy²⁰² by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations.*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people;
- Affordable and clean energy;
- Circular and clean economy.

The **expected impact**, in line with the Strategic Plan, is to contribute to the “*Efficient and sustainable use of energy, accessible for all is ensured through a clean energy system and a just transition*”, notably through

- Technological and socio-economic breakthroughs for achieving climate neutrality and the transition to zero pollution of the **building stock** by 2050, based on inclusive and people-centric R&I (more detailed information below).
- Increased energy efficiency in **industry** and reducing industry’s Greenhouse Gas (GHG) and air pollutant emissions through recovery, upgrade and/or conversion of industrial excess (waste) heat and through electrification of heat generation (more information below).

This Destination has at its core the ambition to deliver on the research, innovation and technological developments needs to meet EU climate and energy targets, forward-looking policy implementation and long-term carbon neutrality objective. The Destination contributes as well (e.g. through the topics that support digitalisation and smartness of buildings) to the EU digital agenda. Though biodiversity is not in the focus of this Destination, the multiple

²⁰² ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

impacts of the built environment on biodiversity (e.g. in the scope of renovation) should be considered.

The Destination has a strong policy dimension – it is steered by EU policy action in the energy and climate domains, the European Green Deal overarching policy priority, the Renovation Wave Strategy (for buildings topics), the Industrial Strategy, the Industrial Emissions Directive (for industry topics) and the forward-looking policy measures proposed in the Fit for 55 – Delivering European Green Deal package.

In the light of the Versailles Declaration²⁰³, and acknowledging the need to reduce the energy dependencies of the EU, this Destination will strongly focus on innovations that boost energy efficiency and reduce energy demand in buildings and the industry, thereby contributing to making Europe independent from Russian gas supplies (and other fossil fuel supply from Russia) by the end of the decade in line with the REPowerEU Communication²⁰⁴.

Highly energy-efficient and climate neutral EU building stock

The Destination will contribute to putting the EU on track for achieving climate neutrality of its building stock by 2050 and to effectively promoting Europe’s independence from Russian gas supplies (and other fossil fuels from Russia) before 2030 by means of a more clean, efficient and sustainable building stock. It will deliver the solutions that can help increase buildings renovation rates, reduce energy consumptions of buildings, improve smart readiness, improve circularity, and improve users’ comfort, well-being and health, while keeping housing affordable, in line with the objectives of the Renovation Wave and the revised Energy Performance of Buildings Directive.

This Destination will contribute to ‘reducing our energy dependencies’ priority of the Versailles declaration across all topics, in particular by improving energy efficiency and the management of energy consumption in buildings, and by delivering more circular approaches to construction and renovation of buildings. The Destination will also contribute to the ‘Electrify Europe’ track of REPowerEU by delivering innovative solutions for energy efficiency and electrification of homes and buildings, e.g. thanks to heat pumps. These priorities are addressed in a specific flagship topic.

It will contribute to the uptake of digital and smart solutions in buildings and to improved energy flexibility, in line with the Action Plan on the digitalisation of the energy sector. The Destination’s innovation will contribute to make the sector fit to support the achievement of higher ambition on energy efficiency under Fit for 55. The Destination’s topics contribute significantly to the New European Bauhaus²⁰⁵(NEB), integrating the core NEB values of sustainability, inclusion and aesthetics in the built environment (e.g. in relation to cultural heritage and quality of experience), and they are consistent with the EU roadmap and policy

²⁰³ The Versailles Declaration, 10 and 11 March 2022, <https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf>

²⁰⁴ ‘REPowerEU: Joint European action for more affordable, secure and sustainable energy’, COM(2022) 108 final, 8 March 2022.

²⁰⁵ https://europa.eu/new-european-bauhaus/index_en

initiatives on digitalisation in the construction sector and on sustainability of buildings (e.g. Level(s)). On climate, one aim will also be to enhance the role of buildings as carbon sinks in the voluntary market for carbon removals, in line with the upcoming Communication on Restoring sustainable carbon cycles and the Proposal for a regulatory framework for carbon removal certification.

The Destination also relies on the Built4People co-programmed partnership's broader action and is complementary to Driving Urban Transitions partnership and to the Mission on Climate Neutral and Smart Cities.

Main expected impacts:

- The European buildings and energy sectors are able to effectively support higher EU ambition on energy efficiency, energy independence, and the transition to zero-emission buildings, with a stronger link between innovation in technology and practices, and policy drivers and instruments.
- Building stocks continue to evolve to combine energy efficiency, renewable energy sources, storage, and digital and smart technologies, supporting the transformation of the energy system towards climate neutrality and reducing Europe's energy dependencies.
- Buildings constructed and renovated see their performance enhanced across the board (energy performance, life-cycle emissions, indoor environment quality), with lower environmental impacts, and rates of holistic renovations continue increasing. Buildings are able to adapt to changing user needs for dynamic and more efficient use of building spaces and they are more resilient to climate change and better integrated in the grid.
- A higher quality, more affordable and inclusive, built environment mitigating climate change and preserving environment, safeguarding cultural heritage, considering sustainability, circularity and aesthetics, while ensuring better living conditions.

Industry

The Destination will contribute to putting the EU on track for achieving climate neutrality of the industrial sector by 2050, while also reducing other polluting emissions, and for effectively promoting Europe's independence from Russian gas supplies (and other fossil fuels from Russia) before 2030 by means of a more clean, efficient and sustainable industrial processes. It will deliver the solutions that can help a faster transition to renewable and low carbon energy sources for thermal energy generation, and a reduction of the energy consumption through waste heat recovery, storage and upgrade for reuse in other processes. These solutions will contribute to reduce GHG and polluting emissions and reinforce the frontrunner and competitive position of the European industry. They are in line with the research and innovations areas identified in the Implementation Plan of the action of the Strategic Energy Technology (SET) Plan dedicated to 'energy efficiency in industry'.

The bulk of R&I dedicated to industry is covered in Cluster 4 (Digital, Industry and Space), and in particular by the private public partnership Processes4Planet focussing on process

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industries. In Cluster 5, this Destination focusses on the management of thermal energy in industry.

Main expected impacts:

- Increasing energy efficiency in industry and reducing industry’s energy dependence, Greenhouse Gas (GHG) and air pollutant emissions through recovery, upgrade and/or conversion of industrial excess (waste) heat and through the integration of renewable energy sources into more efficient and flexible systems for the generation of heat and cold for industrial processes.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D4-01	78.00		20 Apr 2023
HORIZON-CL5-2023-D4-02	44.00		05 Sep 2023
HORIZON-CL5-2024-D4-01		36.00	18 Apr 2024
HORIZON-CL5-2024-D4-02		50.00	21 Jan 2025
Overall indicative budget	122.00	86.00	

Call - Efficient, sustainable and inclusive energy use

HORIZON-CL5-2023-D4-01

Conditions for the Call

Indicative budget(s)²⁰⁶

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²⁰⁷	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 20 Apr 2023				
HORIZON-CL5-2023-D4-01-01	IA	10.00 ²⁰⁸	Around 5.00	2
HORIZON-CL5-2023-D4-01-02	RIA	9.00 ²⁰⁹	Around 4.50	2
HORIZON-CL5-2023-D4-01-03	IA	8.00 ²¹⁰	Around 4.00	2
HORIZON-CL5-2023-D4-01-04	RIA	6.00 ²¹¹	Around 3.00	2
HORIZON-CL5-2023-D4-01-05	IA	25.00 ²¹²	Around 12.50	2
HORIZON-CL5-2023-D4-01-06	IA	20.00 ²¹³	Around 10.00	2
Overall indicative budget		78.00		

General conditions relating to this call

²⁰⁶ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²⁰⁷ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

²⁰⁸ Of which EUR 5.50 million from the 'NGEU' Fund Source.

²⁰⁹ Of which EUR 4.50 million from the 'NGEU' Fund Source.

²¹⁰ Of which EUR 4.00 million from the 'NGEU' Fund Source.

²¹¹ Of which EUR 3.00 million from the 'NGEU' Fund Source.

²¹² Of which EUR 13.82 million from the 'NGEU' Fund Source.

²¹³ Of which EUR 11.00 million from the 'NGEU' Fund Source.

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<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Highly energy-efficient and climate neutral European building stock

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D4-01-01: Innovative cost-efficient solutions for zero-emission buildings

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology</i>	Activities are expected to achieve TRL 6-8 by the end of the project –

<i>Readiness Level</i>	see General Annex B.
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Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased number of solutions and approaches for construction of zero-emission buildings.
- Enhanced productivity of construction compared to standard practice.
- Reduced embodied emission and increased carbon storage, enhanced energy performance.
- Improved comfort, Indoor Air Quality and Indoor Environmental Quality.
- Increased awareness on zero-emission construction best practices.
- Enhanced circularity of construction.

Scope: To demonstrate that high-quality and affordable zero-emission buildings, in line with the Proposed Revision of the Energy Performance of Buildings Directive, can be delivered and mainstreamed. With new buildings already required to be nearly-zero energy buildings, the focus is on how to achieve zero emissions, zero or positive energy standards and how to reduce embodied emissions, also storing CO₂ where possible (using recycled, zero-carbon, or sustainably sourced construction materials acting as carbon sinks).

Proposals are expected to address all of the following:

- Demonstrate innovative construction approaches and scalable solutions based on integrated existing solutions into standardised packages for a cost-effective construction of (new) zero-emission buildings, in line with the Energy Performance of Buildings Directive.
- Ensure the approaches demonstrated:
 - o Allow to achieve zero or positive energy standards and to reduce embodied emissions, also storing carbon where possible, using recycled, zero-carbon or sustainably sourced carbon-storing construction materials.
 - o rely on mature construction products and materials, and technical building systems, seeking to deliver solutions that are ready for application and use, in view of significantly enhancing the energy performance of buildings.
 - o address all components of buildings (envelope, technical building systems, on-site renewable energy – e.g. BIPV – and, where relevant, electric vehicle charging points).

- are rooted in local and regional value chains for sourcing of buildings components and for involvement and upskilling of local and regional businesses.
- are tailored for the applicable regulatory framework: EU, national, and (where relevant) regional and local level.
- have strong potential for replication across Europe, in particular by construction SMEs.
- Demonstrations that include at least three real-life new construction projects, of which one at least should target public buildings.
- Ensure that the demonstrations:
 - Cover at least three countries, with diverse climatic conditions and architectural patterns.
 - Involve local and regional values chains, in particular SMEs, based on participatory approaches to increase innovation acceptability.
 - Lead to clear and, where relevant, quantified and measurable indicators on the results achieved.
- An ambitious EU-wide dissemination roadmap addressing all relevant stakeholders (in particular businesses and authorities) to:
 - promote the zero-emission buildings innovative construction approaches demonstrated.
 - share guidance and recommendations on best practices for zero-emission construction.
 - provide feedback to policy makers at EU, national, and (where relevant) regional and local level regarding the deployment of innovative and cost efficient solutions for constructing zero-emission buildings.

HORIZON-CL5-2023-D4-01-02: Future-proofing historical buildings for the clean energy transition

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.

<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduction of energy demand by at least 60%, preserving historical and cultural heritage values.
- Reduction of on-site construction waste.
- Improved lifetime renovation cost effectiveness compared to conventional renovation.
- Improved comfort, Indoor Air Quality and Indoor Environmental Quality.
- Significant reduction in maintenance costs.
- Where possible, increased potential of successful installation of RES and improvement of smart readiness, in a way that respects the specificities of historical buildings.
- Increased effectiveness and potential for replicability of the proposed solutions.

Scope: Around a quarter of the existing building stock in Europe was built prior to the middle of the last century. Many such buildings not only reflect the unique character and identity of European cities, but also include essential infrastructure for housing, public buildings etc. A significant number of these have a poor energy performance, continue to use conventional and inefficient fossil fuel-based energy systems and are costly to renovate. Furthermore, changes in building use and higher indoor comfort expectations than in the past are driving up energy demand, a particular challenge when historical buildings are used or converted for residential, educational, retail, office or other purposes. Many recently developed renovation approaches are not adapted to the specific requirements of historical buildings. The process of future-proofing these buildings for the clean energy transition faces additional challenges compared to newer buildings, as it has to take into account architectural restrictions, as well as the specificities of the materials used in their construction, which does not respond well to renovation techniques used in modern buildings.

Proposals are expected to address all of the following:

- Deliver standardised renovation approaches and solutions for the deep renovation of historical buildings to improve their energy performance, smart readiness, indoor air quality, comfort, and climate resilience, while respecting their architectural and cultural specificities, materials and traditional construction techniques.
- Target building types constructed prior to 1945 that have restrictions regarding changes of their envelope (walls, window, doors, and/or roof). (Buildings of nationally or internationally recognised significant cultural heritage built after this date may also be considered.).
- Standardised renovation approaches and solutions that are directly replicable for other buildings of the same building type, which should represent a share of at least 1% of buildings in the specific country where they are located.
- Solutions that reduce energy demand in a cost-effective way.
- Explore both internal and external insulation solutions, and where possible incorporating adaptable interventions, plug and play technical building systems, and/or renewable energy services.
- Employ both novel and traditional construction materials and techniques, exploring ways to combine, adapt and improve them.
- Improve the comfort of occupants and lower the maintenance costs for building owners.
- Where applicable, involve relevant conservation authorities.
- Validation of the solutions in a relevant environment (real-life or close to real-life) that:
 - o Covers at least three different countries, with diverse climatic conditions.
 - o Results in clear and, where relevant, quantified and measurable indicators on the effectiveness and the potential for replication of the solutions.

HORIZON-CL5-2023-D4-01-03: Interoperable solutions for positive energy districts (PEDs), including a better integration of local renewables and local excess heat sources

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions

<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²¹⁴ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased availability of tools, guides and interoperable solutions for planning, design, development and management of Positive Energy Districts (PEDs).
- Improved integration of energy (e.g. distributed renewable energy generation, waste heat utilisation, storage) and non-energy sectors (e.g. mobility) within PEDs.
- Improved integration of PEDs in energy systems and improved contribution of PEDs to energy grid robustness with regard to dependencies to energy supplies.
- Increased social entrepreneurship and citizen participation and engagement in energy communities.
- Increased participation of consumers and energy communities in the value chain of the energy system.

Scope: Recent projects have demonstrated positive energy districts, but there is a need to demonstrate fully interoperable solutions that include improved energy efficiency coupled with a better integration of local renewables and local excess heat sources within the district. In parallel, the interoperability of positive energy districts with the urban and renewable energy system in which they are embedded needs to be enhanced through effective solutions

²¹⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

that will allow interaction and integration between buildings, the users and the regional energy, mobility and ICT systems.

Projects are expected to address all of the following:

- Develop solutions (products, tools, etc.) for planning and managing assets (e.g. buildings, energy systems, mobility systems, ICT) in positive energy districts.
- Develop tools and methods for planning and designing PEDs, that support PED developers and managers to optimise the mix of PED solutions depending on the local conditions.
- Develop data exchange platforms (heat & electricity) and technologies to integrate buildings with energy markets (e.g. flexibility market) relying on available standards (e.g. SAREF), allowing buildings to contribute effectively to grid stabilisation at district / city level.
- Develop methodologies and/or planning tools for the optimal integration of distributed renewable generation and excess heat at district (or building) level.
- Develop innovative business models for integration of PEDs in the energy markets including technological, financial and regulatory aspects.
- Deploy and test certification and standardisation frameworks for interoperable solutions in positive energy districts.
- Demonstrate the proposed solutions in at least three PEDs to promote replication, upscaling and mainstreaming.

To ensure interoperability and integration into the grid, projects should make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing Horizon 2020, Horizon Europe as well as under other EU programs such as the Digital Europe Program, when addressing communication and data exchange between inverters and other components, other appliances and the electricity network.

The selected projects are expected to contribute to the BRIDGE initiative²¹⁵, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

²¹⁵ <https://www.h2020-bridge.eu/>

HORIZON-CL5-2023-D4-01-04: Thermal management and energy optimisation of high energy demand IT systems equipment in tertiary buildings

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²¹⁶ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Better understanding of the challenges in thermal management of high-energy demand IT systems equipment in facility rooms inside tertiary buildings.
- Increased knowledge regarding solutions in the tertiary buildings case from transfer of relevant knowledge from other application field/sectors.

²¹⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Improved open access to the relevant and useful knowledge and information for the IT sector.
- Increased awareness of the most common specific use cases in tertiary buildings in EU Member States/Associated countries that could benefit from cost-effective and optimised thermal management and energy efficiency measures (solutions, practices, strategies, etc.), including solutions recovering and valorising of excess heat among others.
- Increased consensus amongst key actors regarding metrics, indicators, reporting, trends, monitoring and verification (M&V) schemes, methodologies & best practices to achieve best/optimal efficiencies through the design, commissioning, operation, management and decommissioning of IT systems equipment.
- Improved insight for future standardisation needs in relevant areas of influence (e.g. procurement, product design, manufacturing, services, cooling equipment, control equipment, buildings energy performance, operation, management, among others.) in order to facilitate further improvements and efficiencies in the relevant areas.

Scope: Energy consumption of IT systems equipment (e.g. server racks, server rooms) inside buildings is following a significant growth due to several factors. These factors include the increasing number of installed sensors and IoT devices, which feeds the need for big data handling and the increasing demand for more powerful and advanced equipment. Various voluntary and regulatory instruments have been implemented in the past years to try to mitigate the environmental footprint of a specific equipment/device or systems in isolation. However, often these instruments do not take into account real life performance, potential inefficiencies or synergies with other systems, operation under real life set-up and control conditions, or other constraints such as those from the building energy management practices, building automation and control systems, local regulations or rules. Moreover, there is potential to improve the self-assessment and self-optimisation functionalities at all levels.

Proposals are expected to address all of the following:

- Validate and improve awareness of the cost-effectiveness and value proposition of the best/optimal thermal management and energy efficiency measures (solutions, practices, strategies, etc.) of high energy-demand IT systems equipment in facility rooms inside tertiary buildings.
- Improve the self-assessment and self-optimisation tools/functionality of IT systems equipment inside high-energy demand IT systems equipment facility rooms of tertiary buildings.
- Facilitate open access to latest information, trends and knowledge to all players involved.
- Promote the best/optimal measures/strategies.

- Engage in the relevant standardisation initiatives and identify needs for future regulation or standardisation developments.

HORIZON-CL5-2023-D4-01-05: Innovative solutions for cost-effective decarbonisation of buildings through energy efficiency and electrification

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 12.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 25.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased application of the energy efficiency first principle in construction and renovation of buildings.
- Increased decarbonisation of building thermal energy demand by means of electrification.
- Enhanced buildings energy performance and (smart) energy management, leading to increased use of locally generated renewable energy and local energy storage.
- Increased number of cost-effective and commercially available solutions for electrification of building thermal energy demand, with significantly lower costs per building unit and significant potential for mass roll-out in Europe.
- Enhanced building contribution to power grid stability by offering energy flexibility services.

Scope: In line with EU priorities for buildings and the energy system, and with the need to reduce Europe’s energy dependencies, to develop and demonstrate highly cost-efficient,

integrated and replicable solutions for decarbonising the thermal energy demand of buildings (i.e. heating and cooling) by means of electrification, ensuring the strict application of the energy efficiency first principle.

Proposals are expected to address all of the following:

- Develop and demonstrate innovative and integrated solutions for electrification of the thermal energy demand of buildings in line with the ‘Electrify Europe’ track of REPowerEU (e.g. heat pumps), with high replication potential across Europe.
- Ensure the solutions developed:
 - o Can be effectively combined with conventional energy efficiency measures (e.g. those that improve the performance of the building envelope).
 - o Can be used optimally in combination with renewable energy sources on-site or nearby.
 - o Include innovative, smart control techniques optimising the heating/cooling systems performance and efficiency based on all relevant parameters, for example, dynamic electricity price (present and future forecast), weather (present temperature and solar radiation, and future forecast, resilience against extreme weather events), thermal comfort, status of charge of electrochemical storage etc.
 - o Include interoperable interfaces and rely on standards allowing to collect and store information on their operation, and communicating with other systems (e.g. building energy management systems or building automation and control systems), for autonomous or remote inspection of systems (state, performance and failures).
 - o Allow to increase the use of locally generated (on-site²¹⁷ and nearby²¹⁸) renewable electricity and electrochemical storage, while offering energy flexibility to contribute to power grid stability.
 - o Minimise life cycle environmental impact and improve circularity (e.g. reparability, modular design for selective replacement and upgrade, recyclability of materials, use of thermal cycle fluids with low global warming potential), while maintaining/enhancing their performance.
 - o Are cost-effective (purchase, installation, operation and maintenance).

²¹⁷ ‘on-site’ means the premises and the land on which the building is located and the building itself.

²¹⁸ ‘energy from renewable sources produced nearby’ means energy from renewable sources produced within a local or district level perimeter of the building, which fulfils all the following conditions: (a) it can only be distributed and used within that local and district level perimeter through a dedicated distribution network; (b) it allows for the calculation of a specific primary energy factor valid only for the energy from renewable sources produced within that local or district level perimeter; and (c) it can be used on-site of the building through a dedicated connection to the energy production source, that dedicated connection requiring specific equipment for the safe supply and metering of energy for self-use of the building.

- o Are highly replicable, for new buildings and for renovation of residential buildings (individual dwellings, single apartments or flats), e.g. for the direct replacement of fossil-fuel boilers.
- Demonstrate the solutions developed in at least five real-life new construction and renovation projects, of which at least two are renovations of residential buildings (multifamily building or individual houses) and at least one is renovation of non-residential buildings.
- Ensure that the demonstration:
 - o Covers at least three countries with diverse climatic conditions, of which at least one country with an energy mix that is strongly dependent on Russian fossil fuel supplies.
 - o Involves local and regional value chains, in particular SMEs, based on participatory approaches to increase innovation acceptability.
 - o Involves relevant authorities to ensure the best alignment with energy strategies at national, regional and local levels.
 - o Is supplemented by an ambitious 5-year replication strategy for the solutions demonstrated, which will be implemented within the duration of, and after, the project.
 - o Leads to clear and, where relevant, quantified and measurable indicators on the results achieved.
- Deliver guidance and recommendations for practitioners, and define and implement ambitious dissemination actions, to promote the approaches demonstrated and support their replication.

Industry

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D4-01-06: Integration of renewable heat or industrial waste heat in heat-to-cold conversion systems to generate cold for industrial processes

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.

<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²¹⁹ .

Expected Outcome: Project results are expected to contribute to all the following expected outcomes, except where options are mentioned:

- Integration of renewable thermal energy sources or industrial waste heat into more energy-, emissions-, cost- and space-efficient conversion systems generating cold for several industrial sectors and processes, maximising primary energy savings and CO2 emission reduction compared to present state-of-the-art, thereby reducing fossil fuel imports dependency.
- Optionally: integration of heat storage, of renewable electrical energy sources; integration of district heating or cooling network.
- Optionally: combined generation of heat and cold for industrial processes.

Scope: Increasing the efficiency of the cooling systems and reducing costs, coupling the cooling systems with renewable energy sources, and harnessing available industrial waste heat (including from data centres), can contribute to reduce the environmental impact and make the industrial sectors more competitive and less dependent on fossil fuel imports.

In order to reach this goal, all the following development areas need to be covered:

²¹⁹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Identify the target industrial processes which would benefit from the integrated cooling systems; assess the impacts on these processes in terms of energy savings and GHG and air pollutant emissions reductions in the EU (and Associated States, if data are available), so as to maximise the impact and coverage of the most promising solutions in the subsequent optimisation and demonstration steps. A preliminary assessment is expected at proposal stage.
- Improve the refrigeration system efficiency and environmental friendliness, for example: improve the control system and operating strategies; develop internal recoveries for refrigeration plants (e.g. vapour compression plants); environment friendly materials and working fluids and novel heat exchangers for refrigeration systems (e.g. absorption systems). Optionally: combine the generation and use of both heat and cold.
- Integrate and demonstrate the refrigeration system in an industrial application in at least one industrial sector, including the mandatory integration of on-site or near-by solar thermal or geothermal plants with minimisation of the space needed. Optionally also: harvesting of industrial waste heat; thermal storage; cold transportation; integration of renewable electrical energy sources, with possible electrical demand flexibility for contributing to the stabilisation of the electrical grid; integration of district heating or cooling network.
- Identify the potential barriers to the deployment of the integrated cooling solutions due to thermal renewables variability, investigating notably other mitigation alternatives than gas-fired backups, such as insurance mechanisms to alleviate the financial risk for the company. Identify non-technical barriers due to the local regulatory framework in the EU Member States and Associated Countries.
- Make an analysis of the potential industrial applications and related benefits (technical, economic, climatic, environmental) of integrated cooling solutions in at least four different industrial processes, in the EU and (if data are available) in the Associated States and, by extrapolation, at global level.
- Define an exploitation strategy. For proposals submitted under this topic, the plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).
- Disseminate the technical and economic benefits, notably (but not only) to the communities of the relevant Horizon Europe private-public partnerships.

Call - Efficient, sustainable and inclusive energy use

HORIZON-CL5-2023-D4-02

Conditions for the Call

Indicative budget(s)²²⁰

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²²¹	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D4-02-01	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D4-02-02	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D4-02-03	IA	12.00	Around 6.00	2
HORIZON-CL5-2023-D4-02-04	CSA	2.00	Around 2.00	1
HORIZON-CL5-2023-D4-02-05	IA	10.00	Around 5.00	2
Overall indicative budget		44.00		

General conditions relating to this call

<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.

²²⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²²¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Highly energy-efficient and climate neutral European building stock

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D4-02-01: Innovative uses of lifecycle data for the management of buildings and buildings portfolios (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	<p>Research and Training Programme of the European Atomic Energy Community (2021-2025).²²².</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.</p>
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Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increase in the availability of key energy and environmental performance indicators from new or improved building management systems that go beyond energy management to life-cycle approach (e.g. environmental performance, circularity, comfort and well-being, indoor environmental quality, accessibility, safety, structural performance, resilience and climate risk vulnerability).
- Improved tools for the planning and management of building assets and portfolios of buildings including energy management, environmental performance, renovation optimisation and investment planning.
- Increased availability and access to lifecycle data of buildings and buildings portfolios and enhanced interoperability and synergies among data sharing platforms.

Scope: European buildings are producing an increasing amount of data on energy and non-energy uses. More and better data can lead to enhanced consumer information, contribute to an effective management of energy grids and support the creation of innovative energy services, new business models and financing schemes for distributed clean energy. Data is also a key enabler for reliable and effective policymaking, e.g. for climate policies. Several recent projects have focused on developing big data facilities and data analytics tools to monitor the energy performance of buildings based on energy related data. More work is needed to integrate energy data with lifecycle data (e.g. GHG emissions and removals, materials, water, health, comfort, life cycle cost and value, etc.), in order to optimise the performance of buildings and buildings' portfolios across the board and support the decision making of owners/tenants/developers to transform existing and planned physical assets (buildings or buildings' assets, e.g. distributed energy generation, e-mobility recharging infrastructure, micro-grids, building systems).

Proposals are expected to address at least two of the three following points:

- Develop new or upgrade existing building management systems enhanced with data analytics and real-time digital twinning tools. The developed systems should take into account buildings monitoring data (e.g. from embedded sensors/actuators), users' preferences (e.g. related to comfort and well-being, safety, and energy flexibility), and

²²² This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

surrounding environmental conditions (e.g. urban density, micro-climate, etc.) in order to optimise operational energy and environmental performance.

- Develop new or upgrade existing decision support tools for the management of building assets and portfolios of buildings. The developed tools should be able to deliver energy (e.g. energy monitoring, renovation optimisation) and non-energy services (investment planning, risk assessment – e.g. risk-related, fault detection, predictive maintenance, surveillance & safety, comfort, occupancy satisfaction). The tools should be co-developed with the potential users (e.g. facility managers, fund managers etc.) and tested in real market conditions.
- Develop new or upgrade existing data sharing platforms including lifecycle data of buildings or buildings portfolios. The platforms should connect relevant market actors (technology providers, developers, aggregators, DSOs, ESCOS) with relevant user groups (consumers, energy communities), policy makers and the financial sector and offer innovative services (e.g. flexibility, prediction, investment planning etc.). The platforms should be co-developed with the participation of the potential user groups and tested in real market conditions linking, where relevant, to digital logbooks and to other relevant initiatives (e.g. the Smart Readiness Indicator under the Energy Performance of Buildings Directive).

Proposals should contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

Proposals are expected to implement at least three large -scale pilots to demonstrate the chosen system. The pilots should cover a variety of building typologies (residential, commercial, public etc.) and use cases (energy monitoring, renovation optimisation, investment planning, risk assessment etc.)

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D4-02-02: Solutions for the identification of vulnerable buildings and people-centric built environment, and for improving their resilience in disruptive events and altered conditions in a changing climate (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.

<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased awareness of approaches for the identification and categorisation of the vulnerability of existing and future buildings and infrastructures.
- Increased number of demonstrated innovative solutions to improve safety and resilience of the built environment, to extreme climatic events, and other natural disasters, as well as to altered conditions due to climate change.
- Increased use of relevant data such as weather forecasts or catastrophe warnings by monitoring and management systems in the built environment (e.g. to launch automatic emergency protocols to warn and protect buildings users).
- Improved understanding of new business models allowing to optimise the costs of resilience, taking into account asset management and lifecycle approaches.
- Increased awareness of building occupants and other key stakeholders on the available solutions in case of extreme climatic events, and natural disasters.

Scope: Buildings should contribute to an integrated approach for a safe and healthy people-centric built environment at block, district and urban level. The built environment needs to be adapted, designed, and constructed for combating the effects of Global Warming (increased heat island effect, increased cooling demands, water scarcity, etc.) and for providing safety and resilience to adverse climatic events at a larger scale, whilst ensuring their connection and integration with energy, ICT and transport infrastructures.

Proposals are expected to address all of the following:

- Develop approaches and tools for the identification and categorisation of the vulnerability of existing, and future, buildings and built environment, where possible using and/or further developing existing vulnerability assessment methodologies.
- Develop innovative designs, materials and solutions to improve safety (e.g., fire safety) and resilience of the built environment to extreme climatic events (heat waves, floods,

category 5 storms, etc.), and which may also be relevant in other natural disasters, such as earthquakes depending on the geographical location of the buildings.

- Ensure, if applicable, that the proposed solutions also improve accessibility for persons with disabilities, improve the local environment, and minimise any negative impacts on biodiversity, e.g. relying on nature-based solutions
- Where appropriate, ensure the proposed approaches and solutions address deep renovation, linking to relevant instruments for awareness and advice of building owners (e.g. renovation passports) in order to gradually adapt buildings to climate change in an adaptation pathways approach.
- Explore the use of relevant data, such as weather forecasts and / or catastrophe warnings, by monitoring and management systems in the built environment (e.g. to launch automatic emergency protocols to warn and protect buildings users).
- Investigate the potential of asset management and life cycle approaches to optimise costs of resilience (e.g. to climate and environmental factors).
- Ensure that the whole value chain from design over construction to end of life is covered.
- Demonstrate the solutions in at least two demonstrators, involving diverse building typologies, at block or district level and including where appropriate the connections to energy, ICT and transport infrastructures, in diverse geographical areas, with various local environmental, social, and economic conditions.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D4-02-03: Demonstrate built-environment decarbonisation pathways through bottom-up technological, social and policy innovation for adaptive integrated sustainable renovation solutions (Built4People Partnership)

Specific conditions	
<i>Expected EU</i>	The Commission estimates that an EU contribution of around EUR 6.00

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Climate, Energy and Mobility*

<i>contribution per project</i>	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Increased number of innovative solutions and packages for sustainable construction and renovation.
- Increased number of options for built-environment decarbonisation pathways towards zero-emission buildings considering the whole value chain at local or regional level.
- Increased engagement and participation of the whole value chain in local and regional innovation clusters.
- Reduced time from first demonstration to market of sustainable renovation solutions.
- Increased awareness and improved access at a local or regional level to information on construction products for reuse and circular businesses.
- Creation of new business opportunities with reduced risk for investment in the circular economy.
- Enhanced engagement amongst communities, businesses, local and regional governments, and the extended construction value chain, e.g. materials and equipment, manufacturers, construction companies.

Scope: To improve the energy efficiency, circularity and sustainability of the built environment there is a need to develop and apply integrated approaches that demonstrate, in practice, achievable pathways for decarbonisation of the building stock through a whole life carbon approach, including temporary carbon storage in built works (e.g. thanks to wood-based products). This means developing and integrating new design techniques allowing for

deconstruction and reuse; new products and components that can be dismantled and reused; and new products and components for construction works that incorporate reused and recycled elements and materials. In addition, there is a need to deploy and test through a value chain approach the enabling conditions that facilitate the integration of the innovations outlined above in planning, design, budgeting, procurement, construction practice, insurance, and related administrative and regulatory processes.

Proposals are expected to address all of the following:

- Demonstrate a value chain approach and pilot decarbonisation pathways in at least two deconstruction/re-use/construction demonstrators and supply chain approaches of market-scale renovations.
- Demonstrate low disruptive and simpler construction and retrofitting processes, which facilitate a life cycle-based approach that fosters alignment with EU Level(s) framework indicators.
- Test the enabling conditions (technological, social, and policy) that can boost innovation and reduce time from research to market of sustainable renovation solutions.
- Establish and operate demonstrative regulatory sandboxes that allow to deploy and test innovation pathways for decarbonisation of buildings at a meaningful scale with the involvement of the whole value chain at local level.
- Where relevant, explore fast tracking of cost-effective standardisation of innovative sustainable renovation solutions.
- Where relevant, investigate non-standard contractual relationships within the design-construction-client project team, including ‘as a service’ approaches for the built environment.
- Develop solutions that can stimulate the market for reused construction products at a regional level in support of the Renovation Wave and which can contribute to increased rate and depth of renovation in order to reach climate neutrality by 2050, in particular in critical segments of the building stocks such as e.g. public buildings or social housing.
- Develop design solutions that address inclusion and accessibility and leading to documented improvements in comfort and health aspects, whilst reducing emissions from the built environment and enhancing climate change resilience.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise (including social innovation), in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D4-02-04: Fast-tracking and promoting built environment construction and renovation innovation with local value chains (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 2.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>The following additional eligibility criteria apply:</p> <p>Projects must cooperate closely with the ECTP network of National Technology Construction Platforms and cross-border/cross-sectoral clusters, as well as with the World GBC European network.</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).²²³.</p>

²²³ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Expansion and strengthening of the Built4People network of Construction Innovation Clusters.
- Increased awareness and improved access at a local or regional level to research outcomes for sustainable built environment construction and renovation.
- Increased engagement and participation of the whole value chain in local and regional construction innovation clusters.
- Strengthened, long-lasting and multi-disciplinary networking and collaboration on locally rooted, bottom-up innovative holistic solutions for a sustainable built environment.
- Enhanced engagement amongst communities, businesses, local and regional governments, and the construction industries and associated supply chains.
- Establishment and reinforcement of European value chains in sustainable construction and renovation.
- Creation of new business opportunities with reduced risk for investment in innovative built environment construction and renovation.
- Reduced time from research to market of innovative sustainable construction and renovation solutions.
- Increased public and private co-financing of innovation in the field of innovative sustainable built environment.

Scope: For effective fast-tracking and promotion of built environment construction and renovation innovation with local value chains, nascent construction innovation clusters need to link with regional/national innovation hubs and clusters. This will strengthen multi-disciplinary networking and collaboration amongst all actors of local and regional construction ecosystems and reinforce European value chains. A long-term network structure is needed, based on an appropriate business model and governance, to support these clusters and give them capacity to nurture and help deliver public and private investments in sustainable construction and renovation innovation also supporting digitalisation of the value chain.

Proposals are expected to address all of the following:

- Delivery of a long-term network structure for the Built4People construction innovation clusters.

- Support adoption of the enabling conditions (technological, social, and policy) that can boost innovation and reduce time from research to market of sustainable renovation solutions.
- Deliver methods and tools for the reliable assessment of innovation maturity and potential impacts (e.g. potential of replication).
- Monitor growth of Built4People construction innovation clusters and assess their effectiveness for reducing the time from research to market of sustainable renovation solutions.
- Stimulate co-financing of innovation in the field of innovative sustainable built environment.
- Disseminate exemplary practices for fast tracking of cost-effective standardisation and certification of innovative sustainable renovation solutions.
- Prepare the value chain at a local/regional level for uptake of innovative sustainable construction and renovation solutions in support of the Renovation Wave and the increased rate and depth of renovation, also post 2030, in order to reach EU-wide climate neutrality by 2050.
- Stimulate engagement in Built4People innovation clusters of the stakeholders that can lead the transformation of the building stocks at local and regional level (e.g. cooperative and social housing developers).
- Promote design solutions that address inclusion and accessibility and leading to documented improvements in comfort and health aspects, whilst reducing emissions from the built environment and enhancing climate adaptation resilience.
- Ensure the project's dissemination activities include actions that contribute to the activities of the NEB Community, and to sharing information, best practices and results within the NEB Lab.
- Seek to ensure consistency and complementarity of action with the project funded under the HORIZON-CL5-2021-D4-02-03 topic.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise (including social innovation), in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

This topic implements the co-programmed European Partnership on 'People-centric sustainable built environment' (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership 'People-centric sustainable built environment' (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D4-02-05: Supporting the creation of an accessible and inclusive built environment (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²²⁴ . The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

²²⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Improved accessibility²²⁵ of the built environment for persons with disabilities and older persons, following a ‘design for all’ approach.
- Improved comfort for larger shares of the population.
- Increased uptake of accessible and inclusive active mobility solutions (walking and cycling) in support of healthy and sustainable lifestyles, while catering solutions for persons with reduced mobility.
- Improved sense of inclusiveness²²⁶ and social cohesion in larger shares of the population.
- Availability of a common evaluation and certification framework for accessibility and inclusiveness of the built environment²²⁷.
- Improved consideration of accessibility and inclusiveness in the transformation of the built environment towards sustainability, climate change mitigation and adaptation, in line with energy and climate ambitions.
- Reduced energy consumption and lifecycle GHG emissions of the facilities of the built environment.

Scope: The focus will be on the different facilities of the built environment (buildings, multi-modal hubs, public spaces and other infrastructure for people’s use) that are open to the public. Built environment professionals require support to design, plan, build and operate facilities that are accessible and inclusive. Design concepts should make these facilities accessible for persons with disabilities and fragile people, following an inclusive, ‘design for all’ approach.

Proposals are expected to address all of the following:

- Develop innovative methods to ensure and facilitate the implementation of accessibility at all stages of design and construction processes, as well as the monitoring and testing of results.
- Demonstrate (and where applicable produce) innovative planning and design tools for new and existing buildings and/or multi-modal hubs and/or public spaces and/or other infrastructure for people’s use with the triple aim of:
 - improving comfort (e.g. improving air quality, reducing noise or vibrations);

²²⁵ Accessibility is meant as the removal and prevention of barriers that hinder the participation of persons with disabilities in society on equal basis with others. In this case the focus is on barriers in the built environment.

²²⁶ Inclusiveness is meant as environments that reflect the diversity of society with full respect of the human rights and fundamental freedoms of all inhabitants.

²²⁷ In line with relevant EU legislation (e.g., the European Accessibility Act Directive (EU) 2019/882) and European standards (e.g., EN 17210:2021).

- o making them accessible and inclusive for persons with disability and/or older persons;
 - o transforming the built environment towards sustainability (including social sustainability), climate change mitigation and adaptation, e.g. relying on nature-based solutions.
- Address the adaptability of the built environment over its lifecycle, to ensure flexibility for accessibility adaptations (e.g., in the case of changing needs of people with increasing disabilities and reducing mobility).
 - Make the facilities of the built environment under consideration more energy efficient overall, therefore reducing GHG emissions.
 - Ensure the involvement of persons with disabilities by means of a participatory approach.
 - Consider the possible creation of new job opportunities that are concerned with implementing, monitoring and maintaining accessibility of the facilities of the built environment.
 - Demonstrate the solutions in at least two demonstrators.
 - Where applicable, investigate solutions aiming at removing barriers, improving storage of (cargo-)bicycles, improving charging possibilities for electric (cargo-)bicycles in an inclusive way (e.g., considering the specific needs of older persons, multi-generational groups, and persons with disabilities).
 - Where applicable, design public spaces to promote soft and active modes of mobility through attractive, safe, and green infrastructure for healthier and environmentally friendly lifestyles, therefore lowering carbon emissions and noise pollution.
 - Where applicable, develop solutions to ensure the mobility of person with disabilities (including visually impaired users) inside buildings in an autonomous, ubiquitous, and pervasive way.
 - Where new digital tools are used in the built environment (including to address energy efficiency and comfort in buildings), ensure their accessibility for persons with disabilities and older persons.
 - Ensure the project's dissemination activities include actions targeted to contributing to the activities of the NEB Community, and to sharing information, best practice and results within the NEB Lab

Infrastructure such as motorways is excluded from the scope.

Participation of / co-creation with relevant societal stakeholders should be part of the action. To this end, this topic requires the effective contribution of SSH disciplines and the

involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise (including social innovation), to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Proposals are expected to contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

Call - Efficient, sustainable and inclusive energy use

HORIZON-CL5-2024-D4-01

Conditions for the Call

Indicative budget(s)²²⁸

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²²⁹	Indicative number of projects expected to be funded
		2024		
Opening: 07 Dec 2023 Deadline(s): 18 Apr 2024				
HORIZON-CL5-2024-D4-01-01	IA	10.00	Around 5.00	2
HORIZON-CL5-2024-D4-01-02	IA	10.00	Around 5.00	2
HORIZON-CL5-2024-D4-01-03	IA	16.00	Around 5.30	3
Overall indicative budget		36.00		

General conditions relating to this call

²²⁸ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²²⁹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Highly energy-efficient and climate neutral European building stock

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D4-01-01: Low-disruptive renovation processes using integration of prefabricated solutions for energy-efficient buildings

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology</i>	Activities are expected to achieve TRL 6-8 by the end of the project –

<i>Readiness Level</i>	see General Annex B.
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Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduction of on-site construction activities to 1-2 days per dwelling/building unit.
- Cost reduction of at least 25% compared to conventional renovation processes.
- Significant reduction of dust, noise and waste on the construction site compared to conventional renovation processes.
- Significant reduction in occupant disturbance during the renovation.
- Improved levels of occupancy comfort (e.g. Indoor Air Quality and Indoor Environmental Quality) after renovation.
- Reduction of negative impacts of renovation on biodiversity, considering adaptability as well (e.g. to climate change, different use, evolving societal needs, etc.) and resilience of buildings to disruptive events.

Scope: Low-disruptive renovation processes, using prefabricated modules that are quick and easy to apply can play an important role in increasing the renovation rate of the European building stock. Renovation processes should cover the whole workflow from design to offsite manufacture, installation, compliance checking on site and end strategies for maintenance, operation and end of life.

Proposals are expected to address all of the following:

- Develop streamlined processes for deep energy-efficient renovation to at least NZEB performance levels using prefabricated modules.
- Use relevant available technologies to reduce quality gaps between the off-site manufacturing and on-site deployment of prefabricated modules.
- Develop processes for seamless integration of prefabricated solutions into a variety of existing constructions (e.g. various existing wall materials, presence of balconies and overhangs, existing piping in the way etc.).
- Ensure the processes minimize the disturbance for building owners, tenants and users, through a considerable time reduction of on-site construction activities, reduced impact in terms of the unavailability of the building and its main functionalities, and a minimal impact on occupancy comfort during the renovation process.
- Include at least three demonstrations covering different building categories (residential or tertiary) and various building typologies, such as single or multi-storey, single or multi-use, etc.

- Demonstrate less-disruptive retrofitting processes that are more attractive and more cost-effective for building owners, tenants and users.

HORIZON-CL5-2024-D4-01-02: Smart grid-ready buildings

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Improved integration of buildings with energy carriers (e.g. electricity grid, district heating networks) and non-energy services (e.g. mobility).
- Improved buildings flexibility for grid and network management.
- Improved contribution of buildings to energy grid robustness with regard to dependencies to energy supplies.
- Increase in renewable energy production and storage at building level.
- Empowerment of end-users by having increased control over their buildings' energy services and contracts (consumption, production, storage, flexibility).
- Enhancement of the smart readiness of buildings as rated by the smart readiness indicator.

Scope: There is a need to deliver solutions to improve the interoperability of European buildings with energy carriers (e.g. electricity grid, district heating networks) and with non-

energy services (e.g. mobility). This will allow buildings to play an active role in the energy system integration.

Proposals are expected to address all of the following:

- Develop new or upgrade existing building-to-grid integration solutions and demonstrate them in real-life pilots. The developed solutions should provide a user-friendly interface for building users and other interested stakeholders (e.g. facility managers, portfolio managers, aggregators) that allow them increased control over the use of their buildings' energy services and contracts (consumption, production, storage, flexibility).
- Enhance interoperability between buildings and grids for electricity and other energy carriers (e.g. district heating networks, hydrogen, etc.) relying on available standards (e.g. SAREF).
- Enhance synergies between on-site energy storage (e.g. home batteries, e-vehicles, etc.) and on-site renewable energy sources.
- Explore solutions for facilitating data exchange between buildings and other grid actors (such as ESCOs, aggregators, DSOs, etc.).
- Develop and pilot innovative and competitive energy balancing, storage and generation services in buildings, while maximising building users' and occupants' comfort and satisfaction.
- Demonstrate the proposed solutions in at least three pilots. Ensure that the demonstrations:
 1. Cover at least three countries, addressing different electricity markets.
 2. Involve local and regional value chains, in particular SMEs, based on participatory approaches to increase innovation acceptability.
 3. Lead to clear and, where relevant, quantified and measurable indicators on the results achieved.
- Demonstrate economic viability of the proposed solutions and business models for consumers and the economic actors involved.

Projects should build on the results from relevant past and on-going projects, in particular those that seek to upgrade smartness of existing buildings relying on legacy equipment (LC-SC3-B4E-3-2020).

To ensure interoperability and integration into the grid, projects should make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing Horizon 2020, Horizon Europe, like the European Science Cloud, as well as under other EU programs such as the Digital Europe

Program, when addressing communication and data exchange between inverters and other components, other appliances and the electricity network.

The selected projects are expected to contribute to the BRIDGE initiative²³⁰, actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the ‘Alliance for Internet of Things Innovation’ (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Industry

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D4-01-03: Alternative heating systems for efficient, flexible and electrified heat generation in industry

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.30 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

²³⁰ <https://www.h2020-bridge.eu/>

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ²³¹ .
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Expected Outcome: Project results are expected to contribute to all the following expected outcomes, except where options are specified:

- Take full advantage of alternative heating systems for electrified, efficient and precisely focussed heat generation in industry, that create the possibility for new, decarbonised and flexible processes, reducing fossil fuel imports dependency, maximising primary energy savings and CO2 emission reduction compared to present state-of-the-art, demonstrated by LCA or similar studies (assuming decarbonised electricity use).
- Environmental and technical performances, health protection, safety and economic viability of novel heating technologies demonstrated and validated in industrial processes.
- Better awareness of the challenges and benefits of alternative heating systems in the relevant industrial sectors.

Scope: Alternative forms of energy such as for example ultrasound, microwaves, plasma, infrared, visible and ultraviolet radiations ... are unconventional and contactless heat sources, that create the possibility of new, efficient and flexible processes, in that they are applied precisely where they are needed and with shortened reaction times. They are key enablers for switching processes from fossil energy to renewable or low-carbon energy sources, and can contribute to increasing their energy efficiency, thereby reducing fossil fuel imports dependency.

They provide higher production flexibility, allowing variable throughputs to better follow market demand and enabling leaner production paradigms (e.g. decreased stock, production on demand), as well as flexibility for the electricity grid via demand response. Furthermore, such technologies are suitable for downscaling, which can be an advantage in some cases (e.g. local waste or biomass feedstock processing).

Note: the electrification of furnaces to heat large volumes at very high temperatures is not in the scope of this topic, because it is covered in Cluster4 work programme.

Further research and upscaling work is necessary to demonstrate their potential to be deployed on an industrial scale.

In order to reach this goal all the following development areas are expected to be covered:

- Cost effective and improved designs for at least two alternative heat sources technologies.

²³¹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Integration and demonstration of the system at industrial scale of at least one alternative heat source technology in at least on industrial process; demonstrate the financial viability and develop a business case.
- Make a preliminary estimation of the future equipment cost for at least one alternative heat source technology, in a total of at least three industrial applications (including the demonstrated application), to evaluate their economic potential.
- Make an analysis of the potential industrial deployment and related benefits (technical, economic, climatic, environmental) of at least one alternative heat source technology in three industrial sectors, in the EU and (if data are available) in the Associated States and, by extrapolation, at global level.
- Define an exploitation strategy. For proposals submitted under this topic, the plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).
- Disseminate the technical and economic benefits, notably (but not only) to the communities of the relevant Horizon Europe private-public partnerships.

Call - Efficient, sustainable and inclusive energy use

HORIZON-CL5-2024-D4-02

Conditions for the Call

Indicative budget(s)²³²

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²³³	Indicative number of projects expected to be funded
		2024		
Opening: 17 Sep 2024				

²³² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²³³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

Deadline(s): 21 Jan 2025				
HORIZON-CL5-2024-D4-02-01	IA	16.00	Around 8.00	2
HORIZON-CL5-2024-D4-02-02	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D4-02-03	IA	8.00	Around 4.00	2
HORIZON-CL5-2024-D4-02-04	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D4-02-05	IA	10.00	Around 5.00	2
Overall indicative budget		50.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Highly energy-efficient and climate neutral European building stock

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D4-02-01: Industrialisation of sustainable and circular deep renovation workflows (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately.

*Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility*

<i>project</i>	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²³⁴ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Streamlining resource-efficient nearly zero-energy performance renovation processes.
- Renovations with reduction of at least 30 % waste, 25% cost, and 30% work time (to 1-2 days per dwelling/building unit), compared to current deep renovation processes.
- Reduced energy performance gap between as-built and as-designed (difference between theoretical and measured performance), and higher construction quality.
- Innovative, tailored business models for deep renovation, generating economies of scale and contributing to an increased rate of renovation.
- Improved comfort, Indoor Air Quality and Indoor Environmental Quality.

²³⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Scope: In line with the Renovation Wave and in order to meet long-term climate and energy targets, more action is needed to increase the rate and depth of building renovation. Several recent projects and calls have focused on prefabrication for deep renovation, but more work is needed to develop innovative, seamless workflows from design to off-site prefabrication, to installation, construction on-site, maintenance and future dismantling, reuse and recycling of prefabricated elements, duly considering life cycle performance, sustainability, and the potential to use the buildings as carbon sinks.

Proposals are expected to address all of the following:

- Investigate innovative approaches for industrialised deep circular renovation, covering the whole workflow from design through to off-site prefabrication, installation, construction on-site and strategies for maintenance, operation and end of life.
- Ensure the proposed approaches aim to achieve the highest level of energy performance (at least NZEB level) with a view toward zero-emission buildings, ensuring a high level of indoor environment quality, keeping costs in an attractive range for owners and investors.
- Make use of innovative processes and technologies, including those delivered by previous research, such as design based on circularity principles, prefabricated components, and digital tools that allow to optimise workflows (cost, time, quality, resource use).
- Demonstrate a seamless integration of the proposed approaches with state-of-the-art digital technologies for construction and renovation (Building Information Modelling, Digital Twins, etc.).
- Select processes and technologies that can be easily tailored to give a maximum potential for rapid and broad deployment at European level.
- Investigate innovative business models (e.g. as-a-service models), accounting for potential market and regulatory barriers, in view of mass deployment and Europe-wide impact.
- Apply the proposed workflows to at least three demonstrations to assess the proposed approaches for different buildings typologies representative of the European building stock, ensuring the most adequate coverage of the respective climatic conditions. The demonstrations can be either single buildings or clusters of buildings, and at least one of the demonstrations has to address residential buildings.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will

be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D4-02-02: Robotics and other automated solutions for construction, renovation and maintenance in a sustainable built environment (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduction of construction and renovation time on-site (at least 40% reduction).
- Reduction of errors in construction and renovation works.
- Improved resource efficiency.
- Reduction of construction and renovation costs.
- Reduction of greenhouse gas emissions resulting from, and improved energy efficiency of the works on-site.
- Reduced environmental impact of construction works, including pollution, particulate matter²³⁵ and noise, in the immediate vicinity.
- Reduction of waste generated from the works on-site.

²³⁵

<https://www.eea.europa.eu/help/faq/what-is-particulate-matter-and>

Scope: The transformation of the built environment should take place in a way that minimises the environmental impact of the works themselves. With the increasing rollout of highly energy efficient, sustainable buildings and deep renovation, there is a growing need for the development of robotic and automated solutions to support sustainable building construction, renovation and maintenance processes that are less disruptive, cleaner and faster.

Proposals are expected to address all of the following:

- Investigate the use of robotic systems (including those used for 3D printing) and automation for construction and deep renovation, in order to reduce time of construction and renovation works, reduce construction errors, as well as facilitate maintenance, also minimising the impact of the works on the surrounding built environment.
- Explore the potential for lower construction costs through automation and robotics resulting from increased speed, improved resource efficiency and avoidance of errors.
- Develop robotic and automated design and construction techniques that increase energy efficiency and reduce greenhouse gas emissions from construction and renovation works on-site.
- Develop approaches that use digitally assisted design to improve resource efficiency and safety, reduce waste, and reduce construction time.
- Investigate the use of automated technologies for surveying, inspection and monitoring of the site.
- Investigate the use of automated support to augment workers' capability and safety (e.g., lift robots, exoskeletons, automated construction site monitoring, use of augmented and virtual reality).
- Test and validate the prototyped solutions in at least three prototypes to assess the proposed approaches for a variety of buildings typologies representative of the European building stock. These prototypes should be validated in a lab or another relevant environment. The testing and validation are expected to address both new construction and renovation.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic implements the co-programmed European Partnership on 'People-centric sustainable built environment' (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership 'People-centric sustainable built environment' (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D4-02-03: BIM-based processes and digital twins for facilitating and optimising circular energy renovation (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs. Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²³⁶ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Reduced buildings construction and renovation time and costs.
- Increased buildings material reuse and recycling.

²³⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Improvement of buildings performance (energy, sustainability including whole life-cycle carbon and the potential to store carbon in built works, comfort, health and well-being, and accessibility).
- Enhanced, interoperable and accessible buildings information across the lifecycle.
- Improvement of interoperability with existing Building Information Modelling (BIM) and Digital Twin solutions.
- Broader application of BIM and Digital Twin solutions, in particular within SMEs.

Scope: To improve Building Information Modelling and Digital Twinning over the full life cycle of buildings, including construction and renovation of buildings, towards enhanced energy efficiency and sustainability and in compliance with circular economy and resource efficiency principles.

Proposals are expected to address all of the following:

- Develop and integrate solutions based on BIM and Digital Twins to support the whole buildings life cycle from design to deconstruction and reuse, including operation.
- Ensure the solutions developed address all the following aspects:
 - Supporting optimal, adaptable and reversible building design for energy efficiency, circularity and sustainability.
 - Allowing to track buildings materials and construction products, and supporting cost-effective deconstruction and reuse, recycling and recovery of building materials at end of life.
 - Integrating buildings monitoring data (e.g. from sensors and IoT devices) into an interoperable Digital Twin for automated, optimised building performance monitoring and management, and preventive maintenance.
 - Enabling buildings data interoperability, quality and integrity across the life cycle, in particular to reliably assess and track building performance over the lifecycle, enabling tailored data access for all life cycle's stakeholders (architects, engineering companies, contractors, building owners, financing institutions, etc.).
 - Relying where possible on open BIM standards and linking, where relevant, to digital logbooks and relevant initiatives (e.g. the Smart Readiness Indicator under the Energy Performance of Buildings Directive).
 - Easiness of use and cost effectiveness, in particular for SMEs and companies with limited experience in digital solutions, and high potential for replication and commercialisation.

- Apply the solutions delivered on a set (at least two) of real-life residential and non-residential building construction and renovation projects which, taken together, allow to demonstrate the potential of the solutions across all aspects listed in the topic and across the life cycle.
- Ensure that the demonstrations of the solutions delivered:
 - o Cover at least two different countries, with diverse climatic conditions.
 - o Involve local and regional value chains, in particular SMEs, based on participatory approaches to increase innovation acceptability.
 - o Result in clear and, where relevant, quantified and measurable indicators on the improvements due to the use of the solutions, for all aspects listed in the topic and across the life cycle.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D4-02-04: Design for adaptability, re-use and deconstruction of buildings, in line with the principles of circular economy (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Improved adaptability of buildings and building units to new uses.
- Increased reuse and recycling of building elements and products.
- Extended service life of buildings.
- Increased awareness on best practices for design for adaptability, reuse and deconstruction.

Scope: Based on the integration of innovative tools, products and techniques, to enable construction and renovation that embeds the principle of extending the service life of buildings, and facilitate adaptability to changing user needs (e.g. for optimal use of indoor space or to improve working and living conditions), reuse, and deconstruction, in a life-cycle optimisation and circular economy perspective.

Proposals are expected to address all of the following:

- Validate construction and renovation solutions based on the integration of innovative tools, products, techniques, processes and methods, that facilitate deconstruction and reuse, based on life-cycle approaches across the value chain.
- Ensure the solutions validated:
 - o Consider the adaptability and reversibility of buildings and building units to changing uses, and to other relevant factors (e.g. evolution of surroundings).
 - o Improve the ease of reuse of construction elements and products from existing buildings, also facilitating recycling when reuse is not possible.
 - o Develop building elements and products that can be disassembled and reused, including those made from CO₂-storing materials such as sustainably sourced long-lived bio-based materials and products and, innovative lower emission materials /aggregates.
 - o Address all components of buildings, including structural elements, envelopes, interior fixtures and fittings, and technical building systems.
 - o Are rooted in local and regional value chains, based on participative approaches for social acceptability of innovation, in particular with regard to the workforce's practices and skills.
 - o Can flexibly adapt to local / regional sourcing of innovative products and materials to increase replication.
 - o Address climate change mitigation, minimising emissions.

- o Allow to minimise any negative impacts of pollution and biodiversity loss from renovation and construction works.
- Validation of the solutions in a relevant environment (real-life or close to real-life) that:
 - o Covers residential and non-residential projects, half of which at least should be renovation projects.
 - o Covers at least two different countries, with diverse climatic conditions.
 - o Involves local and regional value chains, in particular SMEs, based on participatory approaches to increase innovation buy-in from users.
 - o Results in clear and, where relevant, quantified and measurable indicators on the improvements due to the use of the solutions.
- Deliver guidance and recommendations for technology providers, regulatory authorities, certification and standardisation bodies, and define and implement ambitious dissemination actions, to promote the approaches demonstrated and support their replication.
- Where relevant, contribute through specific and targeted actions to standardisation and regulatory evolutions that can foster reuse and deconstruction of buildings materials and products.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

This topic implements the co-programmed European Partnership on ‘People-centric sustainable built environment’ (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘People-centric sustainable built environment’ (Built4People) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D4-02-05: Digital solutions to foster participative design, planning and management of buildings, neighbourhoods and urban districts (Built4People Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²³⁷ .

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Greater engagement of representative groups of end users as well as citizens of the impacted urban context.
- Increased acceptability and uptake of sustainable deep renovation solutions in the built environment.
- Reduced energy and mobility poverty.
- Increase in plans for climate neutral and sustainable, aesthetic and inclusive built environments with enhanced climate adaptation and resilience (e.g. based on nature-based solutions).
- Enhanced climate change adaptation and resilience in built environments.

²³⁷ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Scope: The transition to a climate-neutral society requires that Europe's building stock also becomes climate-neutral. At the same time, Europe's building stock has to become climate resilient. This requires a comprehensive approach beyond individual buildings, namely at the level of neighbourhoods or urban districts. However, the decarbonisation of the built environment and its adaptation to a changing climate and to societal needs in terms of comfort, accessibility, inclusiveness, and aesthetics cannot happen without active participation of the buildings' users and occupants, individual / collective property owners, and energy communities as beneficiaries of the value chain. Professionals, such as project developers, architects, engineers, building owners, planners and statutory authorities, require solutions that develop, analyse, model, visualise and present a multitude and complex set of information in such a way that facilitates such co-design processes. This topic focuses on the development of digital solutions for a stronger participation of end users, citizens and other relevant stakeholders in the design, planning and management of the renovation of existing buildings, neighbourhoods and / or districts.

Proposals are expected to address one or both of the following points:

- Digital solutions that facilitate participative design and planning through visualisation, analysis and engagement with data that is directly relevant to building users as well as citizens in the surrounding urban area (including e.g. immersive and interactive technologies, Virtual Reality / Augmented Reality, simulations and scenario modelling).
- Digital solutions that allow to analyse and model different scenarios for to-be-renovated buildings, neighbourhoods and / or districts in terms of energy use and generation; users' health and wellbeing; impact on the energy grid; provisions for active and electric mobility, and sustainable delivery solutions; life-cycle environmental and micro-climatic impacts, and; socio-economic impacts for citizens, building users, owners and occupiers.

In addition, proposals are expected to address all of the following:

- Address aspects of climate-neutrality and climate-resilience, respecting the 'energy efficiency first' principle.
- Ensure the digital solution complements, builds on and/or uses existing tools (including, where relevant, on conventional, low-tech ones) and standards recognised by the market.
- Engage citizens (seeking coverage of different genders and social characteristics), end users of the tools and other relevant stakeholders involved in the design, planning and management of urban development projects in the development process of the digital solution.
- Ensure the digital solution offers different means to exchange information and provide input that are tailored to the specific needs of laypersons, including vulnerable, minority and disadvantaged groups as well as persons with disabilities and older persons.

- Demonstrate the prototype in at least three real-life urban development projects to apply, evaluate and refine the digital solution and inform its market launch and / or commercialisation strategy.
- Ensure the project's dissemination activities include actions that contribute to the activities of the NEB Community, and to sharing information, best practices and results within the NEB Lab.
- Contribute to the activities of the Built4People partners and to the Built4People network of innovation clusters.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise (including social innovation), in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

This topic implements the co-programmed European Partnership on 'People-centric sustainable built environment' (Built4People). As such, projects resulting from this topic will be expected to report on results to the European Partnership 'People-centric sustainable built environment' (Built4People) in support of the monitoring of its KPIs.

Destination – Clean and competitive solutions for all transport modes

This Destination addresses activities that improve the climate and environmental footprint, as well as competitiveness, of different transport modes.

The transport sector is responsible for 23% of CO₂ emissions and remains dependent on oil for 92% of its energy demand. While there has been significant technological progress over past decades, projected GHG emissions are not in line with the objectives of the Paris Agreement due to the expected increase in transport demand. Intensified research and innovation activities are therefore needed, across all transport modes and in line with societal needs and preferences, in order for the EU to reach its policy goals towards a net-zero greenhouse gas emissions by 2050 and to reduce significantly air pollutants.

The areas of rail and air traffic management will be addressed through dedicated Institutional European Partnerships and are therefore not included in this document.

This Destination contributes to the following Strategic Plan's **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy²³⁸ by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations.*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people;
- Smart and sustainable transport.

The **expected impact**, in line with the Strategic Plan, is to contribute “*Towards climate-neutral and environmental friendly mobility through clean solutions across all transport modes while increasing global competitiveness of the EU transport sector*”, notably through:

- Transforming **road transport to zero-emission mobility** through a world-class European research and innovation and industrial system, ensuring that Europe remains world leader in innovation, production and services in relation to road transport (more detailed information below).
- Accelerating the reduction of all **aviation** impacts and emissions (CO₂ and non-CO₂, including manufacturing and end-of-life, noise), developing aircraft technologies for

²³⁸ ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

deep reduction of greenhouse gas emissions, and maintaining European aero-industry's global leadership position (more detailed information below).

- Accelerate the development and prepare the deployment of climate neutral and clean solutions in the inland and marine shipping sector, reduce its environmental impact (on biodiversity, noise, pollution and waste management), improve its system efficiency, leverage digital and EU satellite-navigation solutions and contribute to the competitiveness of the European **waterborne sector** (more detailed information below).
- Devising more effective ways for **reducing emissions and their impacts** through improved scientific knowledge (more detailed information below).

Several levels of interactions are foreseen with other European initiatives, in particular with the Industrial Battery Value Chain (BATT4EU) partnership, the Cooperative Connected and Automated Mobility (CCAM) partnership and the Mission on Climate Neutral and Smart Cities, in particular:

- Joint topic “2ZERO – BATT4EU” *D5-1-4 B - Innovative battery management systems for next generation vehicles (2ZERO & Batteries Partnership) (2023)*
- Joint topic “CCAM – 2ZERO – Mission on Climate Neutral and Smart Cities” *D5-1-5 Co-designed smart systems and services for user-centred shared zero-emission mobility of people and goods in urban areas (2ZERO, CCAM and Cities' Mission) (2023)*

Zero-emission road transport

Main expected impacts:

- Affordable, user-friendly charging infrastructure concepts and technologies that are easy to deploy with a wide coverage of urban spaces and of the road network and include vehicle-grid-interactions, ready for mass electrification of passenger and freight road transport.
- Accelerated uptake of affordable, user-centric solutions for optimised energy efficiency and energy flexibility (vehicles and services).
- Effective design, assessment and deployment of innovative zero-emission solutions for the clean road transport challenge.
- Innovative demonstrations use cases for the integration of zero tailpipe emission vehicles, and infrastructure concepts for the road mobility of people and goods.
- Increased user acceptability of zero tailpipe emission vehicles, improved air quality, a more circular economy and reduction of environmental and health²³⁹ impacts.

²³⁹ These aspects are also dealt with in the specific “Impact of transport on environment and human health” section

- Support EU leadership in world transport markets at component, vehicle and transport system level, including related services.

Aviation

Main expected impacts:

- Disruptive low TRL technologies that have potential to lead to 30% reduction in fuel burn and CO₂, by 2035, between the existing aircraft in service and the next generation, compared to 12-15% in previous replacement cycles (when not explicitly defined, baselines refer to the best available aircraft of the same category with entry into service prior to year 2020).
- Disruptive low TRL technologies that have potential to enter into service between 2035 and 2050, based on new energy carriers, hybrid-electric architectures, next generation of ultra-high efficient engines and systems, advanced aerostructures that will enable new/optimised aircraft configurations and their cost-competitive industrialisation.
- New technologies for significantly lower local air-pollution and noise.
- Increased understanding and analysis of mitigation options of aviation's non-CO₂ climate impacts.
- Accelerated uptake of sustainable aviation fuels in aviation, including the coordination with EU Member States/Associated countries and private initiatives.
- Maintain global competitiveness and leadership of the European aeronautics ecosystem. Focus on selected breakthrough manufacturing and repair technologies that have high potential to lower the overall operating cost.
- Further develop the EU policy-driven planning and assessment framework/toolbox towards a coherent R&I prioritisation and timely development of technologies in all three pillars of Horizon Europe. Contribute to the mid-term Horizon Europe impact assessment of aviation research and innovation.

Waterborne transport

Main expected impacts:

- Increased and early deployment of climate neutral fuels, and significant electrification of shipping, in particular intra-European transport connections.
- Increased overall energy efficiency and use of renewable energies such as wind to drastically lower fuel consumption of vessels. This is increasingly important considering the likelihood of more expensive alternative fuels, where in some cases the waterborne sector will have to compete with other transport modes.

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- Enable the innovative port infrastructure (bunkering of alternative fuels and provision of electrical power) needed to achieve zero-emission waterborne transport (inland and maritime).
- Enable clean, climate-neutral, and climate-resilient inland waterway vessels before 2030 helping a significant market take-up and a comprehensive green fleet renewal which will also help modal shift.
- Strong technological and operational momentum towards achieving climate neutrality and the elimination of all harmful pollution to air and water.
- Achieve the smart, efficient, secure and safe integration of maritime and inland shipping into logistic chains, facilitated by full digitisation, automation, resilient and efficient connectivity.
- Enable safe and efficient fully automated and connected shipping (maritime and inland).
- Competitive European waterborne industries, supporting employment and reinforcing the position of the European maritime technology sector within global markets. Providing the advanced green and digital technologies which will support European jobs and growth.

Impact of transport on environment and human health

Main expected impacts:

- The reduction of road vehicle polluting emissions (looking at both regulated, unregulated and emerging ones) from both existing and future automotive fleets in urban and peri-urban areas.
- The better monitoring of the environmental performance and enforcement of regulation (detection of defeat devices, tampered anti-pollution systems, etc.) of fleets of transport vehicles, be it on road, airports and ports.
- Substantially understand and provide solutions to reduce the overall environmental impact of transport (e.g.: as regards biodiversity, noise, pollution and waste) on human health and ecosystems.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D5-01	217.00		20 Apr 2023
HORIZON-CL5-2024-D5-01		202.05	18 Apr 2024

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Overall indicative budget	217.00	202.05	
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Call - Clean and competitive solutions for all transport modes

HORIZON-CL5-2023-D5-01

Conditions for the Call

Indicative budget(s)²⁴⁰

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²⁴¹	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 20 Apr 2023				
HORIZON-CL5-2023-D5-01-01	IA	15.00 ²⁴²	4.00 to 5.00	3
HORIZON-CL5-2023-D5-01-02	IA	10.00 ²⁴³	Around 5.00	2
HORIZON-CL5-2023-D5-01-03	IA	20.00 ²⁴⁴	7.00 to 12.00	2
HORIZON-CL5-2023-D5-01-04	RIA	12.00 ²⁴⁵	Around 12.00	1
HORIZON-CL5-2023-D5-01-05	CSA	1.00 ²⁴⁶	Around 1.00	1
HORIZON-CL5-2023-D5-01-06	CSA	1.50 ²⁴⁷	Around 1.50	1
HORIZON-CL5-2023-D5-01-07	IA	20.00 ²⁴⁸	8.00 to 10.00	2
HORIZON-CL5-2023-D5-01-08	RIA	17.00 ²⁴⁹	3.00 to 4.00	4

²⁴⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²⁴¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

²⁴² Of which EUR 8.40 million from the 'NGEU' Fund Source.

²⁴³ Of which EUR 5.60 million from the 'NGEU' Fund Source.

²⁴⁴ Of which EUR 11.20 million from the 'NGEU' Fund Source.

²⁴⁵ Of which EUR 6.70 million from the 'NGEU' Fund Source.

²⁴⁶ Of which EUR 0.50 million from the 'NGEU' Fund Source.

²⁴⁷ Of which EUR 0.84 million from the 'NGEU' Fund Source.

²⁴⁸ Of which EUR 11.20 million from the 'NGEU' Fund Source.

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HORIZON-CL5-2023-D5-01-09	RIA	15.00 ²⁵⁰	3.00 to 5.00	4
HORIZON-CL5-2023-D5-01-10	CSA	2.00 ²⁵¹	Around 2.00	1
HORIZON-CL5-2023-D5-01-11	RIA	16.00 ²⁵²	Around 8.00	2
HORIZON-CL5-2023-D5-01-12	IA	34.00 ²⁵³	8.00 to 13.00	3
HORIZON-CL5-2023-D5-01-13	IA	15.00 ²⁵⁴	Around 7.50	2
HORIZON-CL5-2023-D5-01-14	IA	8.50 ²⁵⁵	Around 8.50	1
HORIZON-CL5-2023-D5-01-15	IA	9.00 ²⁵⁶	Around 4.50	2
HORIZON-CL5-2023-D5-01-16	RIA	9.00 ²⁵⁷	Around 4.50	2
HORIZON-CL5-2023-D5-01-17	CSA	1.50 ²⁵⁸	Around 1.50	1
HORIZON-CL5-2023-D5-01-18	IA	10.00 ²⁵⁹	Around 5.00	2
HORIZON-CL5-2023-D5-01-19	CSA	0.50	Around 0.50	1
Overall indicative budget		217.00		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.

²⁴⁹ Of which EUR 9.50 million from the 'NGEU' Fund Source.
²⁵⁰ Of which EUR 8.40 million from the 'NGEU' Fund Source.
²⁵¹ Of which EUR 1.12 million from the 'NGEU' Fund Source.
²⁵² Of which EUR 9.50 million from the 'NGEU' Fund Source.
²⁵³ Of which EUR 19.00 million from the 'NGEU' Fund Source.
²⁵⁴ Of which EUR 8.40 million from the 'NGEU' Fund Source.
²⁵⁵ Of which EUR 4.80 million from the 'NGEU' Fund Source.
²⁵⁶ Of which EUR 5.00 million from the 'NGEU' Fund Source.
²⁵⁷ Of which EUR 5.00 million from the 'NGEU' Fund Source.
²⁵⁸ Of which EUR 0.75 million from the 'NGEU' Fund Source.
²⁵⁹ Of which EUR 5.60 million from the 'NGEU' Fund Source.

<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Zero-emission road transport

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D5-01-01: User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve at least TRL 6 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: In the coming years, user-centric design, predictive control and artificial intelligence will offer significant opportunities to improve both the design and the operation of electric vehicles (EV) to make them more affordable, efficient and offer an even more attractive driving experience. This includes particularly the potential for improved thermal energy management, ranging from the HVAC system and components to powertrain and

vehicle interior thermal design. Project results are expected to contribute to all the following outcomes:

- Accelerated uptake of affordable and more energy efficient electric vehicles (EVs) through the development of innovative and holistic user-centric solutions, optimized system concepts and components sizing.
- Increase comfort and safety (e.g. de-misting) functions' effectiveness and leading to a real world range increase of 20% (compared to the chosen State of the Art donor vehicle or demonstrator) at external temperature of 0 degrees Celsius
- Component sizing and performance matched to vehicle reliability and performance requirements to reduce costs by at least 5% at vehicle level.
- Reduced development time at vehicle systems and components by 30% through the use of Artificial Intelligence (AI) for advanced design support and control algorithms in EV holistic thermal management and powertrain systems.

Scope: This topic's scope relates to both the operational perspective (especially intended vehicle usage, as well as user behaviour, preferences, route planning, infrastructure, weather conditions, etc.) and the technological perspective, addressing new concepts and components, their efficiency, as well as new approaches based on artificial intelligence (AI) employed in design, development and controls, and the potential of cloud-based solutions.

Proposals should involve all relevant stakeholders and are expected to address all of the following aspects:

- Development of optimised heating/cooling and demisting concepts and components capable of greatly reducing energy consumption to perform these functions, particularly when coupled with smart controls.
- Development of methods to automatically pre-condition vehicles prior to trips and enabling self-adjusting control strategies during operation. This includes vehicle systems, powertrain electric and thermal management based on AI supported learning/analysis of EV user driving patterns, travel route conditions and weather conditions to maximise the range benefit.
- Data driven decision making enabling optimal interior design fulfilling perceived driver needs, as well as, e.g., AI supported adjustment of operation and controls of the system including of powertrain and auxiliary, components and their thermal state as well as cabin comfort to avoid peak loads and ensure minimum energy consumption.
- Identify the optimal system layout and possible interactions through multiple scalable digital twins (thermal modelling of vehicle, powertrain, components and the driver).
- New modular interoperable systems to enable the use of real-life data from vehicle fleet operation to automatically (pre-)adjust control parameters and minimize engineering

effort in calibration stage as well as to maintain optimal performance over vehicle life-time, e.g., to enable continuous learning of the applied AI and adaptability to work on-board in “real-time” control systems, while considering the access needs of third parties for services such as repair and maintenance. Protection of users’ data must be guaranteed.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-02: Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

- A simplified, efficient and connected battery management system (BMS) including a reduction of parts and cost (optionally by using cloud-based battery status calculation with adequate consideration of security aspects provided a low overall climate impact), including data necessary for second life and Vehicle-to-everything (V2X) applications.

- Improved and optimized monitoring and predictive diagnostics for a more accurate reliable and efficient battery management maintenance (data-driven diagnostics, over-the-cloud software updates and firmware replacements, self-testing and on-board diagnostics) that are accessible to other third parties in non-discriminatory terms, for instance for maintenance or reuse.
- Development of relevant interfaces to allow access to the BMS and its database by vehicle charging infrastructure and related mobility services providers with the consent and input of EV driver preferences through an appropriate user interface, for instance for battery and cabin pre-conditioning, minimum final state of charge selection etc.
- Generally improved exploitation of battery performance (such as faster charging and enhanced regenerative braking control for higher energy recovery), and increased battery pack volumetric density (by 10% or more due only to BMS contribution compared to 2022 State of the Art), safety and prolongation of battery life-time (by at least 30%) by considering algorithms for cell level state of health, cell aging prediction and battery state estimation, including also the integration of smart sensor systems – with validation under real driving conditions (demonstrating up to 15 years lifetime in the future).
- Improved control of battery operating conditions and determination of key state estimators (SoX = e.g. State of Health, State of Power, State of Safety, State of Charge) to increase accuracy and to improve the early warning capability for performance, reliability, safety, and lifetime issues on all battery system levels.
- New simulation tools and test methods for faster development, validation and integration of the battery pack, considering assembly design (reducing cabling for the external voltage detection communication function) and realizing a reduction of testing time by 30% (collection of battery characteristics for SoX algorithm optimisation using less calibration).
- Enhanced communication between battery and vehicle control unit for a more efficient battery operation by synchronizing the electronic control units (ECUs) of the BMS and the EV.

Scope: Advances in the design, functioning and data accessibility of an efficient battery management system (BMS) are of high significance when it comes to the integration of batteries in electric vehicles (passenger cars and commercial vehicles) and the general improvement of battery performance.

Proposals are expected to address all the following aspects:

- Predictive SoX diagnostics (based on sensing at cell level) to accurately predict the end-of-life, as well as high connectivity and data storage to optimize the life and general use of the EV.

- Advanced use of physics-based, data-driven or hybrid models in general, considering for example Artificial Intelligence (AI) with machine learning algorithms, model training and self-adaptive functions.
- Secure, real-time and databased battery management to reduce margins in a controlled manner and to ensure optimized, safe utilisation during all modes of operation and accurate classification for a second life.
- A link between the BMS and the ECU of the vehicle to exchange data about weather, temperature, speed, topographies, etc. and detailed information on battery operation, thereby achieving the best possible battery monitoring, diagnostics and lifetime, while optimizing driving range.

Proposal should leverage and not duplicate activities underway under Important Project of Common European Interest (IPCEI) and Batteries partnership ²⁶⁰, and link with projects funded under topics:

- HORIZON-CL5-2022-D2-01-05: Next generation technologies for High-performance and safe-by-design battery systems for transport and mobile applications (Batteries Partnership);
- HORIZON-CL5-2022-D2-01-09: Physics and data-based battery management for optimised battery utilisation (Batteries Partnership).

Where appropriate, links will need to be ensured with projects funded under topic HORIZON-CL5-2024-D5-01-03: Advanced battery system integration for next generation vehicles.

Projects should take into account the access to battery information as defined in the proposal for the Renewable Energy Directive COM(2021)557 of 14 July 2021.

This topic implements the co-programmed European Partnerships on ‘Towards zero emission road transport’ (2ZERO) and Batteries (Batt4EU). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) and Batteries (Batt4EU) in support of the monitoring of their KPIs.

HORIZON-CL5-2023-D5-01-03: Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 7.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

²⁶⁰ <https://bepassociation.eu/synergies-and-collaborations/ipceis/>; <https://bepassociation.eu/>

<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to deliver solutions tailorable for specific usage models and particular market factors in order to contribute to all of the following outcomes:

- Accelerated global uptake of affordable, user and mission centric solutions tailorable for specific usage models e.g. occasionally transporting additional passengers (and particular market factors both in advanced and emerging markets).
- Effective design, assessment, and deployment of innovative low-cost but upgradable Electric Vehicles solutions (powered two-wheelers, light cars or minibuses) for the clean urban transport challenge.
- Higher sustainability and minimized cost by leveraging economies of scale but still offering flexible variations through modularity.
- Ensured ease of use in targeted urban and sub-urban areas that accounts for traffic and parking conditions as well as for battery charging/swapping points availability.
- Lower energy consumption by means of vehicle tailored to the urban environment conditions and constraints (e.g. lighter mass, suitable range and dynamic performances, higher utilisation of local resources, including reuse of components and systems, and eco-sustainable materials²⁶¹).

Scope: Urban spaces will be changing in the future. There will be a massive shift from the parking-lot culture in the city to recovery of living spaces as well as increasing intelligence in the urban spaces. Both will have a strong impact on individual means of mobility. New vehicle concepts that harmonize with these new developments, but also achieve widespread user-acceptability, will be needed. Platform concepts with sufficient variability will be able to meet the needs of both advanced and emerging countries.

²⁶¹ The future Commission initiative for 'Safe and Sustainable by Design' will set a framework for assessing safety and sustainability of chemicals and materials and should be considered as a baseline for proposals.

New designs, shapes, architectures, and functionalities capable of delivering mass-market capable frugal versions for emerging markets and versions in the EU, associated countries and advanced markets with a single, generic platform, including swappable and interoperable battery systems (for L-category) should be covered. Proposals should address battery electric vehicles that are specifically better suited for operation (in appropriate versions) in future urban spaces both in emerging as well as established markets.

Proposals are expected to address all the following aspects:

- Systematic and thorough analysis of user centric needs, due to future evolution of urban areas representative for both emerging and established market use cases and of the required infrastructure development (e.g. charging infrastructure and related information and communication technologies).
- Development and demonstration of at least two variations of the modular and scalable vehicle (i.e. basic low-cost version and higher value version based on the same adaptable platform with high-production volume potential; optionally and additionally, proposals can foresee an extension to goods transport). For L-category vehicles this should include the option of swappable and interoperable standard battery systems (across world regions, for larger economies of scale) which can optionally be used for light vehicles or minibuses, for instance for range extension or emergency use.
- Validation with real electric vehicle(s) and related battery solutions testing, demonstrating the developed functions, in particular the capabilities of the proposed architecture in terms of payload, charging requirements, vehicle efficiency to optimise range and battery sizing, also to match local needs.
- Confirmation of user acceptability by showcasing the solutions in both emerging markets and established markets according to the purpose of the particular version.
- Assess the potential impact in terms of emissions reduction considering the potential scale-up opportunities of the addressed use cases, prioritizing higher impact use cases.
- Taking into consideration future development pathways for urban public, semi-public, private charging infrastructure adapted for such future urban vehicle concepts, in particular in the developing countries where such infrastructure is currently non-existent.
- Projects should deliver digital twin models of the demonstrator vehicles, so that the impact of the innovations towards the overall objectives of the 2ZERO partnership might be determined. Data that are produced as output from a ‘digital twin’ will be enacted in line with FAIR principles for data²⁶², and deposition in relevant repositories should be encouraged.

International cooperation with emerging economies e.g. from Asia and Africa is encouraged.

²⁶² Final Report and Action Plan from the European Commission Expert Group on FAIR Data, “TURNING FAIR INTO REALITY” - https://ec.europa.eu/info/sites/info/files/turning_fair_into_reality_0.pdf

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-04: Circular economy approaches for zero emission vehicles (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve at least TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Implementing a consistent circularity along the electric vehicle (EV) value chain and life cycle (in particular for mass produced Light Duty vehicles but with potential learning for other types of applications) will be a significant factor to reach the goals defined in the European Green Deal.

Project results are expected to contribute to all the following outcomes:

- Increasing the degree of circularity of EVs, thus reducing their environmental footprint over the full life cycle. Specific circular design approaches are needed in particular for some light-weighting materials (recycling of fibre reinforced materials and advanced steel, aluminium and magnesium alloys), reuse and recycling technologies for new types of components (traction motors, electronic components, wire bundles, etc.) and improved post shredder technologies supporting higher recovery of critical raw materials.
- Increasing the awareness and acceptability of circular economy and Life Cycle Assessment (LCA) based design of innovative zero-emission solutions for the clean road transport challenge.

- Contributing to a harmonised way of measuring the circularity of the economy in the automotive industry.
- Demonstrating the potential of these actions by delivering a circular car prototype (test bench ready) aiming at 0% virgin material use by mass for all vehicle components except cells, e-machines and electronics.
- Accelerating the transformation of Europe towards being the first digitally enabled, circular, climate-neutral and sustainable economy.
- Improving markets for secondary raw materials and facilitate higher uses of recycled content of plastics, glass and possibly REEs in the automotive supply chain.
- Contributing to Europe's world leadership in automotive innovation, production and services through increasing skills with circular economy techniques and accelerating the uptake of innovative circular economy-based solutions for EV, reducing the dependency on critical raw materials via the consistent recovery and use of secondary materials.

Scope: The objective will be to demonstrate the feasibility of circular economy (CE) and net-zero approaches for the EV value chain over its full lifetime (cradle to cradle). The proposed activities should focus on vehicle production (design, manufacturing and assembly), maintenance, repair and End-of-Life (EoL). Additionally, LCA-based vehicle concepts, their related resource and energy efficient manufacturing and CE consistent EoL strategies should be shown.

Proposals are expected to address all the following EV-related research activities:

- Developing an appropriate set of technologies, from production (design, manufacturing and assembly) until End-of-Life and demonstrating their feasibility on vehicle level over the full life cycle by means of prototypical manufactured components ready for test benches verifications. This includes a re-design of components for circularity.
- Assessing the potential for high value and/or energy or rare material content components to be refurbished and reused in new vehicles or as spares.
- Enhancing digital tools enabling a higher degree of circularity along the automotive value chain, e. g. supporting circular design and development, manufacturing or to track materials, their use and the EoL.
- The impact of maintenance and repair technologies and operational strategies will be developed or adapted to ensure a higher degree of circularity compared to existing practices in the passenger car industry.

- Deriving a concept for measuring and assessing the circularity of EV solutions as well as for ensuring a sufficient exchange of information along the automotive supply chain applying FAIR principles²⁶³.
- Concepts for training and increasing the required skills in the automotive industry regarding CE.
- A digital twin of the demonstrator should be used to assess various scenarios, including the exclusive use of recycled or bio-based materials and for the assessment of KPIs.

The research activities are expected to apply the findings of vehicle level LCA methodology developed by the CSA funded under HORIZON-CL5-2021-D5-01-04 as far as they are available. International cooperation addressing requirements of and the impact on global supply chains is encouraged.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-05: Measuring road transport results towards 2ZERO KPIs (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 1.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant</i>	The rules are described in General Annex G. The following exceptions apply:

²⁶³ Final Report and Action Plan from the European Commission Expert Group on FAIR Data, “TURNING FAIR INTO REALITY” - https://ec.europa.eu/info/sites/info/files/turning_fair_into_reality_0.pdf

<i>Agreements</i>	Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁶⁴ .
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Expected Outcome: In its Strategic Research and Innovation Agenda (SRIA²⁶⁵), the 2ZERO partnership identified a large number of Key Performance Indicators (KPIs) related to its general, specific and operational objectives – that are not directly under the control of the 2ZERO partnership. In order to analyse the effectiveness and impact of the research and innovation actions in this relevant area, project results are expected to contribute to all the following outcomes:

- Account for the contribution of the 2ZERO partnership and the results of its projects, towards its main goals (as measured against the whole set of the identified KPIs).
- Support the identification and quantification of all interactions, impacts and effectiveness of the partnership within the road transport challenge, mainly as a result of the information gleaned from the 2ZERO partnership project results.
- Provide additional recommendations for further development and analysis of means of measurement and evaluation of the partnership within the road transport challenge.

Scope: In order to properly monitor the contribution of the different funded projects to the achievements of the 2ZERO partnership objectives, a common framework for monitoring and assessment of the results needs to be agreed, ultimately allowing their comparison and a proper evaluation of their cumulative benefits at an EU level. Moreover, general objectives, such as a carbon-neutral road transport system by 2050, air quality, technology leadership, economic growth, European competitiveness, and circular economy aspects should be also addressed. In order to do so, proposals are expected to address all of the following aspects:

- Assess and measure results related to the specific partnership KPIs, how they are predicted to vary (as a consequence of the project outcomes) in the 2025 to 2035 period.
- Exploit the capabilities and techniques generated through the development and delivery of digital twin representations and of the results of the 2ZERO funded projects.
- Address at least the means of measuring all relevant parameters related to the 2ZERO KPIs: more generically, climate, air quality and circular economy aspects could also be quantitatively projected.

²⁶⁴ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

²⁶⁵ <https://www.2ZEROemission.eu/wp-content/uploads/2021/12/2021-2ZERO-SRIA-FINAL-1.pdf>

The project’s main governance (e.g. Steering Group, Advisory Board) is expected to provide for direct involvement of all relevant stakeholders, as well as relevant European Commission services. The selected project will cooperate with the 2ZERO partnership that shall on its side provide access to all needed data and element in order to perform the foreseen activities.

The project should take account Open Science, its practices and learning, and the project’s results will be enacted in line with FAIR principles for data²⁶⁶.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-06: EU Member States/Associated countries research policy cooperation network to accelerate zero-emission road mobility (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 1.50 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

²⁶⁶ Final Report and Action Plan from the European Commission Expert Group on FAIR Data, “TURNING FAIR INTO REALITY” - https://ec.europa.eu/info/sites/info/files/turning_fair_into_reality_0.pdf

	Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁶⁷ .
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Expected Outcome: European Commission and EU Member States/Associated countries are reinforcing and developing their research & innovation policy to accelerate zero-emission road mobility development. A framework for cooperation will enhance the efforts to achieve this pan-European challenge by joining forces, sharing knowledge, bundling financial resources and coordinating activities, creating complementarities, coherence and building synergies across the EU (e.g. 2ZERO partnership) and EU Member States/Associated countries' R&I funding programmes, national plans, efforts, approaches and in collaboration with the Associated Countries.

Project results are expected to contribute to all the following outcomes:

- Stronger harmonised national policy plans, efforts, approaches with a focus on R&I funding programmes of the different EU Member States/Associated countries, accelerating zero-emission road mobility.
- Maximally deployed and effectively utilised synergy effects, pooled resources and aligned R&I funding programmes to support the EU 2030 and 2050 CO₂ emission goals for the road mobility sector in an affordable and effective way.
- Exchange of knowledge and experiences and mutual coordination at multiple levels (EU/national / regional / cities and stakeholders, funding organisations, OEMs, fleets, users, etc.), implementation activities, regulations, incentives and demonstrations and the sharing of data, information and best practices.
- Provide companies, regions, cities and the research community with a holistic overview of policy plans and R&I funding programmes across EU (and Associated Countries) to maximise synergy effects and the efficient utilisation of resources, such as from recovery packages and cohesion funds.
- Allow a clear overview of the national projects and better take into account their results in the development of their research and deployment actions.
- In order to facilitate the above-mentioned coordination of efforts at national and EU level and the sharing of best practices and results, data on national projects (to a level at least equivalent to those present in the CORDIS database) should be made available by MS and AC. The consortium will endeavour to promote and harmonise the registration of data on national projects of participating countries, to make data more accessible internationally and to facilitate their exchange and comparison. This will be supporting

²⁶⁷ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

the integration of data on national projects into existing databases, such as TRIMIS and CORDIS.

- Long lasting, strong coordination and cooperation between the European Commission, MS and AC and the Stakeholders involved in the 2ZERO Partnership, facilitated by the States Representatives Group (SRG).

Scope: Although there is a relatively large degree of similarity in the targets and approaches of the EU Member States and Associate Countries to address the climate change targets, still considerable differences in the paths can be observed: more coordination and collaboration is urgently needed to promote zero emission road mobility, building on the policy cooperation network of the EU Member States/Associated countries built-up in ERA-NET Transport, Electromobility+ and ERA-NET Co-fund Electric Mobility Europe (EMEurope) with over two decades of experience.

Proposals are expected to address all of the following aspects

- Address zero-emission road mobility for people and goods programmes supporting all phases of the innovation: technology development, demonstration, deployment and implementation will be considered.
- Develop a long-lasting network (beyond the project duration) of public and private stakeholders connecting EU Member States/Associated countries and European initiatives, under the umbrella of the 2ZERO partnership States Representative Group (also building on existing links with the supporting European technology platforms ALICE, ETIP-SNET, EPoSS, ERTRAC and Batteries Europe) to share knowledge, coordinate activities and bundling financial resources to achieve synchronicity, synergies and complementarity in the R&I-related plans, efforts, approaches, incentives and funding programmes to effectively support the EU and national objectives for 2030 and 2050.
- More concretely contribute to:
 - Support EU Member States/Associated countries in implementing and accelerating priority actions identified in the 2ZERO Strategic Research and Innovation Agenda (SRIA) in coordination with the 2ZERO States Representatives Group.
 - Collect and share, up-to-date and targeted information on European and national R&I funding programmes, demonstration projects and testing activities, test sites, living labs with their features and capabilities, standards, testing and assessment methodologies as well as programmes in the field of zero emission mobility in Europe and beyond.
- Exchange knowledge and experiences on zero emission road transport programmes in Europe, building on and connecting existing database platforms, such as TRIMIS, 2ZERO events and conferences, including the H2020RTR series, Member State's and stakeholder's information sharing portals.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

Aviation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D5-01-07: Hydrogen-powered aviation

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve at least TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Innovative ground-based refuelling and supply systems for liquid hydrogen at air transport ground infrastructures, with the potential to be up-scaled at system level by 2027.
- Transformative aircraft-based hydrogen refuelling technologies, with emphasis on safety, standardisation and scalability to various types of aircraft concepts (including Vertical Take Off and Landing aircraft (VTOL) and Unmanned Air Vehicles (UAV)).
- Hydrogen-powered aircraft ground movements, demonstrated and scalable across airports of different sizes, locations and capacities in Europe.

- Comprehensive and validated liquid hydrogen demand and supply-matching models at air transport ground infrastructures in Europe and globally, towards a potential entry into service of hydrogen aircraft by 2035.
- New standards and certification procedures for the roll-out of the new technologies and solutions at large scale, in EU Member States/Associated countries and on the TEN-T network.

Scope: Hydrogen-powered commercial aviation is today on a promising path towards climate neutrality by 2050, with European industry setting 2035 as an expected date of entry into service of the first hydrogen-powered commercial aircraft. While the Horizon Europe Clean Hydrogen partnership focuses on the production side (e.g. developing new fuel cells and hydrogen storage technologies), the Clean Aviation partnership addresses the integration and demonstration of disruptive technologies, including ones on hydrogen-powered aviation and subsequent aircraft architectures. However, there is currently a clear research and innovation gap for the phase in-between. Most notably, this gap relates to the demonstration of hydrogen refuelling and supply from air transport ground infrastructures to the aircraft, with follow-on demonstrations of ground-based aircraft movements (e.g. taxiing). In particular, hydrogen refuelling entails significant operational issues, safety risks and other barriers (e.g. scalability) at both air transport ground infrastructure and aircraft levels. This has the potential to create a bottleneck for Europe to proceed on the path to climate neutrality, lower emissions and reducing Europe's dependency on oil and fossil fuels, which are clear objectives of the Versailles Declaration²⁶⁸ and REPowerEU²⁶⁹. At the same time, demonstration pilots of hydrogen-powered aircraft ground movements need to start urgently, in order to be able to achieve full operations of hydrogen-powered airplanes in the EU by 2035.

In this context, building on good practices, studies and research projects (e.g. Horizon 2020 green airport projects, Horizon 2020 ENABLE-H2), as well as other policy initiatives (e.g. Fit for 55 and ReFuelEU Aviation), actions should address all of the following aspects:

- Assessing and validating potential liquid hydrogen demand models at air transport ground infrastructures in Europe and globally, considering also multimodality issues at airports arising from the use of hydrogen in road and rail transport. The techno-economic assessment should also consider the energy supply side and be aligned with the targets, investments and regulatory aspects addressed by REPowerEU, ReFuelEU Aviation, the Alternative Fuels Infrastructure Regulation and the Trans-European Networks for Transport and Energy (TEN-T and TEN-E).
- Testing and demonstrating innovative and safe ground-based refuelling, storage and supply systems for liquid hydrogen at air transport ground infrastructures, going beyond the state-of-the-art and in view of future standardisation, with focus on airports and vertiports serving national, intra-European and/or regional routes. Consideration should

²⁶⁸ <https://www.consilium.europa.eu/en/press/press-releases/2022/03/11/the-versailles-declaration-10-11-03-2022/>

²⁶⁹ https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511

also be made to the hydrogen production (including on-site), supply, materials performance, storage and refuelling systems, with the concurrent use other liquid fuels (e.g. kerosene and sustainable aviation fuels) and electricity at air transport ground infrastructures, in order to enable zero-emission airport operations along the entire value chain, from multimodal road/rail connections, to ground handling and aircraft ground movements.

- Developing and demonstrating new aircraft-based hydrogen refuelling technologies, with emphasis on operational feasibility, safety, interoperability, standardisation, scalability and cost optimisation, to showcase a clear technical and business case. The technologies should be compatible with various propulsion technologies and aircraft concepts (e.g. different types of commercial aircraft and architectures, including VTOL and UAV, as also addressed in the Horizon Europe Clean Aviation partnership.
- Performing small-scale demonstration pilots of zero-emission hydrogen-powered aircraft ground movements, in one or two airports (e.g. taxi-in / taxi-out), in view of deploying the new technologies and solutions to various aircraft types and airports across Europe.
- Initiating and developing new standards and certification procedures, for the new technologies and systems to be scalable and serve different types of aircraft and air transport ground infrastructures of various sizes, locations and capacities for both passenger and freight transport.

The EU's Hydrogen Strategy prioritises renewable hydrogen (low-carbon hydrogen being considered a transitional technology) and should be taken into account to develop the proposals, considering, inter alia, how the hydrogen will be produced and supplied.

The topic aims to exploit synergies with the Horizon Europe Clean Aviation and Clean Hydrogen partnerships, for the roll-out of transformative aircraft liquid hydrogen propulsion technologies, with an eye towards future large-scale demonstrations and real-life airborne plane trials during the later phase of the Clean Aviation partnership. The retained proposals, should, during the implementation phase, regularly exchange information with the Technical Committee and the Governing Board of the Clean Aviation and Clean Hydrogen partnerships respectively (in-line with articles 65 and 80 of the COM(2021) 87).

For standardisation activities and in view of future certification of airports and vertiports and aircraft, including VTOL and UAV, the participation of EASA is deemed necessary to address airport and aircraft certification issues. The involvement of airports, vertiports and aircraft manufacturers in the project activities is required. Since regional and short haul aviation is likely the first segment to start the transition to hydrogen-based fuel technology, the involvement of regional and insular airports in the project will be an asset.

In line with the Union's strategy for international cooperation in research and innovation, the participation of airports and regulatory bodies outside of the European Union is encouraged.

Projects should collaborate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

HORIZON-CL5-2023-D5-01-08: Accelerating climate-neutral hydrogen-powered/electrified aviation

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 3.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 17.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 2-3 by the end of the project – see General Annex B.

Expected Outcome: Project results should focus on transformative technologies that address existing technology gaps for an aircraft hydrogen and electrified powertrain of a megawatt class. Project results are expected to contribute to one of the following expected outcomes:

- Deliver transformative aircraft energy storage, conversion and distribution technologies for hydrogen and electrified propulsion that exceed the state-of-the-art.
- Deliver novel heat dissipation, thermal management and recuperation technologies for megawatt class, that exceed the state-of-the-art.
- Deliver advanced simulation tools, validation methodologies and control approaches for an aircraft hydrogen and electrified powertrain of megawatt class.

Scope: The proposal is expected to develop further transformative technologies, at low TRL, that have potential to be reviewed and considered for further development and demonstration beyond 2027, towards contributing to aviation climate neutrality by 2050. Electrified aircraft propulsion is the use of electric motors to drive a subset or all of its propulsors. Hydrogen and electrified aircraft propulsion explicitly expands the scope to include hydrogen combustion propulsion.

Hydrogen as energy carrier and batteries as energy storage have the potential to eliminate aviation CO₂ emissions as well as reduce non-CO₂ ones. Key enabling technologies for aircraft thermal and power management have been identified as showstoppers for their integration.

The topic is open also to fundamental hydrogen research - relevant to aviation – which can be combined to any of the three expected outcomes, such as:

- better understanding of advanced materials’ compatibility and capability in aircraft hydrogen and electrified powertrain applications including effect of water vapour from hydrogen burning;
- computational materials science and innovative characterisation techniques across different length scales.

Beyond the development of transformative systems, the topic may consider the development of innovative control approaches as well as simulation tools and validation methodologies for hydrogen and electrified powertrain of a megawatt class. The development of dedicated test benches (at a TRL range within the scope of this call) should exploit synergies with the CA (cf. note).

The topic aims to exploit synergies with the Clean Aviation partnership, towards developing transformative aircraft hydrogen and electrified powertrain technologies, with an eye towards their review, selection and further development during the second phase of CA. The retained proposals, should, during the implementation phase, regularly exchange information with the Technical Committee and the Governing Board of the Clean Aviation and Clean Hydrogen partnerships respectively (in-line with articles 65 and 80 of the COM(2021) 87).

The topic is not open to hydrogen and electrified architectures, their integration and new aircraft configurations, as those are dealt exclusively in the Clean Aviation partnership (except aircraft types/missions not covered by the CA partnership). Activities should exploit synergies with the Clean Aviation (CA) partnership, with an eye towards their review, selection and further development during the second phase of CA.

To topic addresses primarily to RTOs/Academia/SMEs with guidance and support from aircraft high-tier suppliers and integrators.

Projects should collaborate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

HORIZON-CL5-2023-D5-01-09: Competitiveness and digital transformation in aviation – advancing further capabilities, digital approach to design

Specific conditions	
<i>Expected EU</i>	The Commission estimates that an EU contribution of between EUR 3.00

<i>contribution per project</i>	and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.

Expected Outcome: Project results should focus on innovative hybrid numerical/experimental procedures, tools and methodologies that will advance further the industrial aircraft design capabilities. Project results are expected to contribute to at least one of the following expected outcomes:

- Multi-disciplinary and multi-fidelity design and optimisation integrated tools for industrial environment.
- New advancements in aerodynamics and aeroacoustics (with emphasis on interference), including data-driven (Artificial Intelligence – Machine Learning, Hybrid modelling) high-performance computing and advanced validation-verification procedures.
- Advance further design for manufacturing optimisations, including additive manufacturing, circularity and sustainability aspects.
- Methodologies for simulation, testing and further certification of urban air-mobility safety critical applications, considering for example, virtual or extended reality technologies.

Scope: The proposal is expected to develop further advanced computational/experimental procedures/methodologies and industrial aircraft design capabilities that have potential to contribute to the digital transformation of the European aircraft supply chain.

Aircraft development requires testing for airframe, dynamic systems, materials performance, new manufacturing techniques, propulsion, cabin and system and their sub-components in order to ensure their performance but also the highest level of safety. As a result, the proposal is also expected to develop methodologies and approaches dedicated to the use of combined experimental testing with numerical simulation in order to enhance the testing results and their integration - and therefore accelerate the development cycle.

Regarding the expected outcome on urban air-mobility safety critical and hazardous missions, the scope is expanded to mission specific testing of the whole aerial vehicle after system integration.

The proposal should seek to exploit synergies with Clean Aviation (and big demonstrations in the second phase of the partnership) such as ground vibration testing, flutter mitigation, design of Ultra performant aircraft, advanced dynamic systems, hydrogen systems testing, thermal management, flight testing and long-term hydrogen exposed materials behaviour testing. The retained proposals, should, during the implementation phase, regularly exchange information with the Technical Committee of the Clean Aviation partnership (in-line with article 65 of the COM(2021) 87).

All developed hybrid numerical/experimental procedures and methodologies should be benchmarked (e.g. drag prediction, solver convergence, grid optimisation) for challenging industrial cases. Proposals that include virtual certification are encouraged to invite the participation of EASA.

To topic addresses primarily to RTOs/Academia/SMEs with guidance and support from aircraft high-tier suppliers and integrators.

HORIZON-CL5-2023-D5-01-10: Aviation research synergies between Horizon Europe, AZEA and National programs

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 2.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for

	Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁷⁰ .
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Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- Coordinate and support synergies between European, National and Regional R&I aviation programmes.
- Contribute to the preparation of the European Aerodays 2024-2025.
- Support the Alliance on Zero Emission Aviation (AZEА).

Scope: The overall scope of this coordination and support action is to provide support and advice to the European Commission on anticipated and small ad-hoc actions within 2023-2025 period.

The action should contribute to the coordination and support of synergies between European, National and Regional R&I aviation programmes, including joint calls or other co-funding mechanisms aligning EU, National and Regional activities in specific fields. The action is also expected to assist the European Research Area (ERA) in accelerating the update and sharing of aviation technology infrastructures. Close collaboration with ACARE is expected.

The action should contribute to the organisation and preparation of the European Aerodays 2024-2025 as well as other ad-hoc communication activities.

Finally, the action should contribute to the communication of the impact of EU aviation research and relevant policies (Fit for 55, Industrial Strategy, Alliances, Space Policy) and provide support the Alliance on Zero Emission Aviation (AZEА) work with ad-hoc mapping and analysis, including identification of potential technology gaps and lack of related R&I and standardisation efforts.

Waterborne transport

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D5-01-11: Developing the next generation of power conversion technologies for sustainable alternative carbon neutral fuels in waterborne applications (ZEWT Partnership)

Specific conditions

²⁷⁰ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Establish the basis for the on-board deployment of power conversion technologies for sustainable alternative climate neutral fuels by 2030;
- Validate the technical feasibility of the use of innovative power conversion technologies for sustainable alternative carbon neutral fuels in waterborne transport;
- Prove the scalability to power outputs significantly above 3 MW with acceptable power density and high efficiency; Validate achievement of the additional KPIs of; minimum 5 kW/m³ power density (refers to power density of the energy converter, i.e. excluding storage of fuel or liquid electrolytes); minimum 45 % total system energy efficiency including all required ancillaries with zero carbon or climate neutral operation weighted over the MARPOL Annex VI E2 or E3 cycle;
- Support regulatory development within both EU and IMO frameworks;
- Prove the safety of the proposed solutions through verifiable KPIs for the use of the fuel and power conversion system concerned;
- Validate resilience of the power system to possible fuel impurities and variability of the power required by the ship;
- Developed a realistic pathway to the wider use of power conversion system technologies in waterborne transport (e.g. Long Distance, Inland, Cruise, Ferries, Short Sea and Offshore);

- Risk assessed the power conversion system with respect to lifetime, maintenance scheme and life cycle cost as well as a life cycle GHG emissions;
- Where relevant, be coherent with the activities of the Batteries co-programmed partnership and the Clean Hydrogen Joint Undertaking.

Scope: Sustainable climate neutral fuels with emissions considered on a full well to wake life cycle basis are expected to be essential to decarbonise deep sea, large scale and energy intensive shipping, with their associated high-power demands. A range of candidate fuels are advocated, including for example liquid and gaseous advanced biofuels and liquids, advanced synthetic renewable energy carriers, green hydrogen, green ammonia and green methanol. Whilst power conversion technologies for these fuels, include novel internal combustion engines and fuel cells are being addressed by ongoing R&I, whilst power outputs are slowly increasing, in most cases, they remain well below that needed for a primary power source which is usable for commercial shipping and systems remain very sensitive to fuel impurities, whereas high purity fuel cannot always be assured for waterborne transport. Large uncertainties with respect to the operational and capital costs are also a barrier for innovative technologies being taken up in the market.

To be widely deployed, new power conversion technologies are expected to be technically and economically viable for integration on board ships. They have to be capable of delivering:

- High powers for prolonged periods,
- A power density which would be acceptable for integration within ship structures,
- High efficiency, without increasing air pollutants.

Progress beyond the state of the art is required. To facilitate scalability, the developed power conversion technology should be robust to the typical fuel qualities expected within a waterborne transport environment as well as potential contaminations introduced when blending different fuels, while maintaining endurance and reliable power output with reduced air pollution. Power conversion technologies have to be also robust under variable power demand, experienced in typical seaways and ship manoeuvres.

The topic is open to all potentially sustainable climate neutral fuels and all energy conversion technologies, including but not limited to Internal Combustion Engines, Turbines and fuel cells.

Projects are expected to advance beyond the state of the art addressing all the following aspects,

- Develop and validate, in a laboratory or relevant environment, power conversion technologies for sustainable alternative climate neutral fuels. Scope should include ship configuration, performance simulation and scenario comparisons to enable the use of one or more fuels onboard the ships;

- Validate in a relevant environment resilience to fuel impurities accepted by the power system and to cope with the variable power demand;
- Potential fuel blends and combinations should be considered as solutions to reach required power conversion performance, taking into account; any increase in total energy (or even decrease) output compared to current fuels, lowest possible levels of noise and air pollutant emissions (SO_x, NO_x, CO, PM, ammonia slip, nitrous oxides), and the lowest possible well-to-wake GHG emissions.
- In addition, safety KPIs for the use of the fuel concerned, in particular when using green ammonia and methanol, should be developed and verified.
- The projects should undertake a risk and predictive assessment of lifetime of the power conversion and fuel system, the life-cycle cost throughout vessel life, maintenance scheme, as well as the life-cycle cost and GHG emissions on a well-to-wake assessment basis.
- Develop a realistic pathway to the wider use of power conversion system technologies in waterborne transport

Where relevant, plan for synergies with the activities of the Batteries co-programmed partnership and the Clean Hydrogen Joint Undertaking.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-12: Demonstrations to accelerate the switch to safe use of new sustainable climate neutral fuels in waterborne transport (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 8.00 and 13.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 34.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

	additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Full scale on board operational demonstration of a sustainable climate-neutral fuel system, including fuel distribution, bunkering, fuels storage, power conversion and possible residue handling, in a realistic on-board operational environment;
- Verifiable KPIs to prove the effectiveness, viability, and impact of the demonstrated solutions;
- KPIs to be demonstrated include: ship power optimisation; bunkering specificity (equipment, safety, operations, flowrate); energy consumption efficiency in waterborne transport; reduction of the global emission of GHGs; life-cycle GHG emissions on a well-to-wake assessment basis and reduction of the air pollution emissions (notably SO_x, NO_x, CO, PM, black carbon) in a range of operating scenarios.
- Accelerated transition to climate-neutral or zero-emission maritime and inland ship operations, by facilitating the wider adoption of sustainable climate neutral fuels at a larger scale and for vessels requiring prolonged autonomy. Particularly focusing on fuels where significant on-board challenges remain, with consideration of the specific supply chain requirements to satisfy the needs of maritime transport and inland navigation, in particular shipping activities with frequent cargo handling operations.
- Demonstrated possibilities from smart digitalisation, to facilitate the on-board use of sustainable climate neutral waterborne fuels.
- Demonstrate achievement of the 2040 targets specified within the European Commission proposal for a Fuel EU Maritime regulation reference COM/2021/562.

Scope: Whilst smaller scale demonstration of vessels running on potentially sustainable climate neutral fuels have been ongoing in the waterborne transport sector²⁷¹, large-scale demonstrations, particularly with more challenging fuels such as hydrogen and ammonia for which end-to-end transnational operations, safety, environmental effects, risks and their mitigation are still lacking. The assessment of the results from such large-scale demonstrators are necessary to trigger the wider adoption of sustainable climate neutral fuels within the waterborne transport sector.

Adoption of sustainable climate neutral fuels within waterborne transport assets will in turn be possible only if the outstanding challenges of the daily operations are solved, for example

²⁷¹ Waterborne transport concerns both maritime shipping and inland waterway transport, explanation of the segments is included in the Strategic Research and Innovation Agenda of the ZEWT co-programmed partnership.

bunkering, storage, handling and on-board operations have to be proven safe. Sustainable climate neutral fuels include potential new safety issues, such as toxicity, different flashpoints or fire hazards which are expected to be addressed.

Operational performance and efficiency of the overall system in full operations have to be demonstrated, especially with respect to air pollution (NO_x, SO_x, PM, methane or ammonia slip, black carbon etc.) and well to wake GHG emissions. The systems, processes and components needed to handle and use sustainable climate neutral fuels will also be demonstrated. Continuous emission and performance monitoring systems and their integration are an additional challenge that should be taken into consideration, including monitoring of emission profiles and identifying operating patterns that require optimisation as well as the identification and management of potential trade-offs.

Smart digitalisation also provides new opportunities to facilitate the efficient, clean and safe use of climate neutral sustainable fuels, for example by enabling advanced engine emission management.

Activities will also underpin the pre-normative R&I required to facilitate the routine deployment of Sustainable Alternative Fuels (SAFs).

Demonstration within operational conditions is targeted. The challenge is to increase confidence in, and acceptability of, the viability of sustainable climate neutral fuels where full operational demonstration has yet to be achieved, including for example green hydrogen, green ammonia, green methanol sustainable liquid and gaseous advanced biofuels and other advanced intermediate bioenergy and synthetic renewable energy carriers, together with their associated power systems.

Projects are expected to address **all** of the following aspects **either** for a) inland waterway transport or b) maritime transport applications:

- Develop, validate and demonstrate a sustainable climate-neutral fuels system on board, in full transnational operations including fuel distribution, bunkering, fuel storage, power conversion and possible residue handling. A minimal power of 1MW (for either full or partial vessel power), addressing significant challenges and going beyond state-of-the-art as well as demonstrating achievement of FuelEU Maritime 2040 targets is required. Demonstrating higher powers which will be applicable to a wider range of applications is encouraged. Due to the scale of resources required, for option a) inland waterway transport- demonstration is expected to be undertaken on more than one vessel type, for option b) maritime transport- it is optional to demonstrate more than one vessel. Use of replacement renewable low carbon fuels in otherwise conventional oil/gas-based energy conversion technology should not be considered.
- Demonstrate applicability of sustainable climate neutral fuels in particular considering stricter environmental expectations and regulations, such as those applicable to passenger ships, inland waterway transport and other environmentally sensitive regions.

- Provide validated risk and safety assessments, mitigation measures and demonstration supporting the development of safety provisions in regulation proposals both in EU and potentially at IMO, ISO and inland waterway regulatory frameworks and taking into account operational conditions such as cargo handling activities.
- Demonstrate the capacity of innovative smart digitalisation to facilitate the safe, clean and efficient on-board use of sustainable climate neutral fuels.
- Plan for the exploitation and dissemination of results for proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (such as the Innovation Fund).
- Proposals should plan and propose relevant synergies with relevant Horizon Europe activities such as the Clean Oceans Mission, the Batteries co-programmed partnership and the Clean Hydrogen Joint Undertaking results and activities arising from projects under topics HORIZON-CL5-2021-D5-01-07 or HORIZON-CL5-2021-D5-01-14.

Projects are expected to address either a) inland waterway transport or b) maritime transport applications.

To ensure coverage of both areas, the most highly ranked projects scoring above the minimum threshold will be selected in each area. Subsequent projects will be ranked and selected based upon their scoring. Proposals are expected to clearly indicate if area a) inland waterway transport or area b) maritime transport is the focus of the application.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-13: Integrated real-time digital solutions to optimise navigation and port calls to reduce emissions from shipping (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions

<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Technology Readiness Level</i>	<p>Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.</p>

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Progressing beyond the state of the art, full-scale demonstration of an interoperable port call and voyage optimisation tool on existing routes and services involving at least three ports and two shipping companies and relevant stakeholders in port call operations.
- Improved operational efficiency of vessels when arriving to/departing from ports, towards elimination of waiting times during navigation and at the port. Develop and demonstrate in realistic environment, KPIS's to quantify these gains.
- Increased navigational safety through improved sea traffic management from onshore which has been assessed with respect to the status quo considering also situational awareness during port entrance, manoeuvring, berthing, departure and potentially related skills issues.
- Optimised fuel efficiency and reduced vessel emissions through voyage, waiting at anchorage and port arrival optimisation to facilitate more efficient sailing speeds. Reductions in fuel consumption of 10 to 20% with corresponding reductions in greenhouse gas emission should be demonstrated, compared to business as usual during navigation and at port and port-to-port approach.
- Enable shipping companies to quantify their fuel savings and the GHG emissions avoided as a result of the optimisation system and the real-time information shared with ports during vessel voyage.
- Development of port call optimisation standards considering the on-going standardisation initiatives by IMO/ISO groups to facilitate a secure and resilient operational, real-time digital data sharing and decision support system for port and

voyage optimisation; and develop operational roadmap(s) for standard technical committees.

- Assessment and quantification of the benefits of port and navigation optimisation for different types of maritime traffic, e.g. tramp and regular services for bulk, container, passenger, cruise ships, Ro-Pax, Ro-Ro, etc.
- Adaption to the existing and/or development of business models to prove the commercial viability of voyage and port call optimisation to facilitate take up and its wider application.

Scope: Shipping is frequently subject to prolonged waiting periods offshore before birthing and offloading cargo. Vessels waiting at anchorage pending the availability of port capacity reduce operational efficiency as well as increasing emissions, either whilst waiting or due to faster sailing speeds to arrive at port in case of birth availability. To avoid these situations, port call optimisation systems have been developed and are now being piloted. However, these have been generally limited to specific services. More widely applicable navigation and port call optimisation tools which can address the entire voyage, promote the most efficient sailing speeds to reduce emissions and ensure direct berthing without delay could substantially improve operational efficiency and reduce emissions.

Activities should take a holistic approach to the development and scale up of an integrated port scheduling and voyage optimisation tool to address real multi vessel traffic scenarios, focussing on vessel routing and voyage optimisation, minimising emissions and the eventual port call process, going beyond existing systems and combining the perspectives of both shipping and port operators.

Proposals are expected to address all of the following aspects:

- Develop collaborative harmonized collaborative standards and communication amongst relevant stakeholders to enable an interoperable optimisation system to be deployed across the operations of the stakeholders concerned. Thereby facilitate the real time sharing of operational digital data, supporting enhanced situational awareness and decision support to reduce emissions through lower total voyage fuel consumption. For example, the following functions may be included; cargo handling, port services, clearance, commercial services such as bunkering, onshore power connection, berth availability, terminal capacity, weather, sailing speed, voyage data etc. Standards should address security, resilience as well as potential integration within existing port infrastructures and their monitoring systems.
- Develop methodologies and tools to enable information sharing and optimisation of routes and time of arrival in real time, including decision algorithms that use methods such as AI, Edge Analytics, heuristics, and business analytics.
- Using existing routes and services, progressing beyond the state of the art, demonstrate the operation at full-scale of an interoperable port call and voyage optimisation tool

towards at least three ports and two shipping companies in addition other stakeholders linked to port call operation.

- Consider system security as well as resilience and mitigation actions in case of failure.
- Carry out risk assessment for the developed solutions, using existing models (such as FSA, HAZOP, etc.) to support safety and business continuity in case of failure as well as regulatory development at IMO and EU level.
- Address the full voyage, including vessel positions far from port, to maximise emission reduction and operational efficiency benefits. Data sources should include among others weather, consumption, emission, traffic and port planning.
- Build upon existing systems, technologies and regulations (for instance, European Maritime Single Window and other national undertakings) to ensure direct applicability with existing requirements. Other innovative and new technologies can also be deployed.
- Develop and measure KPIs for efficiency from real cases, including calculation of the gains from the application of the solutions developed within the project. Measure the resulting reduction in emissions achieved as a result of the voyage and port scheduling optimisation system compared to a typical similar non-optimized service.
- Plans for the exploitation and dissemination should include a strong business case and sound exploitation strategy, as outlined in the introduction to this destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used

Participation of end users in proposals is necessary. Commitment from end users towards the deployment of solutions developed in the project will be considered positively. All proposals will need to demonstrate a clear and credible pipeline from development to the operational deployment of the solution following the projects end.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-14: Developing a flexible offshore supply of zero emission auxiliary power for ships moored or anchored at sea deployable before 2030 (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 8.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.50 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- In close cooperation with ship owners, operators and ports, demonstration and testing of an innovative solution to provide auxiliary power and possibly battery charging for ships moored and anchored at sea which will cut pollution and GHG's and which can be deployable before 2030;
- Developing guidelines on technical, operational and safety aspects for the provision of offshore power supply services;
- Assessing the GHG and polluting emission savings from ships moored or at anchor through verifiable KPIs;
- Assessment of the CAPEX and OPEX of the developed solution and optimisation of the concept to increase the financial viability of the developed solution.

Scope: The provision of electric energy to vessels at port is a mature technology which provides important benefits in terms of reducing the emissions from the waterborne transport sector, not only for CO₂ but also for other pollutants. Within Europe this is particularly important as many ports are either an integral part of densely populated cities or very close to them. The provision of onshore power supply (OPS) to vessels in European ports forms an integral part of the “Fit for 55” initiative. Due to direct electrification being more efficient, OPS is an important long-term solution applying to vessels with other clean technology solutions which will become more widely available. So far, the provision of OPS has been designed and applied for vessels securely berthed at terminals. This is an important step, which needs to be encouraged. However, in many cases, vessels need to spend important time at port anchorage, before a berth at a terminal is available. Some vessels such as cruise ship may also disembark their passengers to tenders offshore. During this period, vessels are using their main or auxiliary engines, thus creating emissions which impact port cities and coastal areas as well. A solution needs to be developed which can provide OPS to these vessels whilst

not at berth. Current consideration of such applications has been mainly limited to barge mounted solutions and concept development of offshore cabled power buoys (e.g. floating power plants, LNG HIVE2, OPS barges and offshore charging buoys). Generally, solutions are not yet mature and, in several cases, use fossil fuels. Consequently, a range of other possibilities may remain. The solutions to be developed and demonstrated by the projects are expected to address all the following aspects:

- The project should develop and test potential solutions for the provision of electric power to maritime vessels (primarily container ships and passenger vessels, including cruise ships) of at least 5000 GT.
- Be adaptable, so that as required, power can be provided to different locations within the port anchorage.
- Develop and demonstrate a solution which is flexible in terms of area of application i.e., that can be deployed in other areas within a port or possibly be moved to other ports, including if relevant, both inland and seaports.
- Be based on direct electrification from shore grid connections or offshore renewable power or the use of sustainable alternative fuels including for example liquid and gaseous advanced biofuels, synthetic renewable energy carriers or energies.
- Aim to minimize air pollution, including when solutions are founded upon biofuels.
- If applicable, assess the possible use of circular energy sources such as those from industrial processes taking place within the port perimeter (chemical processing, scrap processing, melting etc.).
- Aim for operational deployment by 2030. Minimize costs taking into account Capex and Opex with consideration of the energy conversion efficiency, the cost and availability of the supplied sustainable alternative fuels and/or energies.
- Pay particular attention to all safety aspects relating to the provision of clean energy, while a vessel is at anchorage.
- Evaluate the range of applicable regulatory instruments by reaching out to relevant Authorities.
- For example, the proposed solution maybe founded upon one of the following concepts, although other concepts may also be proposed:
 - Barge mounted generators, using sustainable low GHG fuels.
 - Floating energy storage units, using batteries together with inverters and a capability to provide the typical total energy need of a ship at a port anchorage.
 - Barge mounted fuel cells using green hydrogen fuel or other climate neutral sustainable alternate fuel.

- o Cabled offshore power supply connections towards buoys or other supply interface.
- Plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D5-01-15: Reducing the environmental impact from shipyards and developing a whole life strategy to measure and minimise the non-operational environmental impacts from shipping

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute concretely to the following expected outcomes whilst supporting the overall medium- and long-term impacts marked “*”:

1. *Reduce the non-operational environmental impacts from shipping including construction and end of life strategies.
2. *Understand the most significant environmental factors in shipbuilding and throughout a ships circular life cycle including ship repair and the associated costs.

3. * Enhanced environmental and personnel awareness. Development of skills for greening of shipyards to improve the environmental performance and productivity in shipbuilding and ship repair processes.
4. * Enhanced circularity of waterborne transport assets through recycling and re-use of materials, parts and components.
5. * In the long term, contribute to the objective of a ship environmental performance indicator of the non-operational environmental impacts from the ship which takes construction, embedded materials, capacity for repair, end of life strategies into account.
6. Development of a shipyard environmental performance index (SEPI), relevant KPI's and benchmarks for shipyards through an inquiry into current shipyard processes and utilities (i.e. energy use and emissions to air, water and earth);
7. Demonstration of advanced production processes which reduce the environmental impact of shipyards and assessment of the shipyards' environmental performance (SEPI) which would achieve an improvement in environmental performance utilising current benchmarks, of at least 20%.
8. Development of a generic digital shipyard model encompassing shipyard processes with the associated energy use and emissions, enabling to assess and benchmark the environmental performance and cost-efficiency of shipyards and their contribution to the environmental impact assessment within the ships' Life Cycle (LC).
9. Development of guidelines on technical, organisational and personnel training solutions for reducing energy use and emissions to air, water and soil and improving the environmental performance of shipyards.
10. Development of a blueprint for an EU-material passport for waterborne transport assets classifying the ship circularity readiness level (CRL). In addition, a guideline for the passport maintenance throughout the ship life cycle backed by a business model for circularity and an appropriate regulatory regime in line with Regulation (EU) No. 1257/2013 on Ship Recycling (EU SRR) and coordinated with other ongoing Horizon 2020 / Horizon Europe projects.

Scope: The environmental impact of ships throughout their operational life is governed by the IMO Energy Efficiency Design Index (EEDI, mandatory for new ships), the Ship Energy Efficiency Management Plan (SEEMP, all ships), as well as by IMO and EU GHG-targets for 2030 and 2050 respectively. In addition, the IMO Carbon Intensity Indicator (CII) for all cargo, RoPax and cruise vessels above 5,000 GT and trading internationally will come into effect in 2023. To ensure that ships at the end of their operational lives can be recycled and do not pose any unnecessary risks to human health, safety and harm to the environment, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was introduced in 2009. Furthermore the 2013 EU ship recycling regulation sets higher standards and requires that from 2019 ships have to be recycled within an approved facility.

Furthermore, Green Passport and Green Passport EU may be assigned to ships by class societies which include an Inventory of on-board Hazardous Materials (IHM).

Assessment of a ships full environmental value chain misses in particular:

- Sufficient data or industry standards to describe the characteristics of a ships non-hazardous materials which may contribute additional value from recovery, recycling and re-use. For example, in line with "circular economy" principals, a cradle-to-cradle material passport which is analogous to that applied within the building industry is missing.
- Key performance indicators (KPI's) addressing the environmental impact shipyard pollution to air, water and earth caused by shipbuilding, ship maintenance, repair, retrofit and dismantling. High performance and clean production processes.
- The contribution from the shipyards towards ship design and the application of non-hazardous recyclable materials beyond the current IHM-passport.
- Guidance concerning best practices to minimise the non-operational environmental impacts from shipping considering construction, materials, capacity to repair, design and capacity for recycling. For example, including difficult materials such as plastic composites.

Activities will address the greening of shipyards, facilitating clean, efficient, low-energy processes which minimise pollution to air, water and earth and contribute to increasing ship circularity.

Proposals should address all of the following points:

- Develop and validate an environmental performance index with corresponding KPI's and determine a benchmark for shipyards through an investigation of shipyard floor processes, logistics and utilities i.e., energy use and emissions to air, water and earth, taking into account current environmental regulations, including those applicable to other land-based industries which may apply to shipyards.
- Identify the contribution of shipyards and ship design to the circular life cycle of ships in terms of reuse of components and materials within the context of shipyard processes, the shipbuilding value chain, capacity for repair and refit, end of life circularity and disposal value/cost. Considering also difficult materials such as reinforced plastics.
- Develop and validate a digital shipyard model encompassing shipyard floor technologies and logistic processes with the associated energy use and emissions, links to safety (e.g., ventilation to reduce indoor VOC's increasing energy consumption), enabling the assessment and benchmarking of the environmental performance of shipyards and the impact of "clean floor" technologies on shipyards.

- Develop and validate in line with the “Green Passport” a material circularity passport for maritime assets and identify the role of the manufacturing and design value chain stakeholders to apply best practices to increase circularity, reduce life cycle impacts and optimise end of life value. Foresee the compilation and maintenance of the passport over the ship lifecycle.
- Plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy. The exploitation plans should include preliminary plans for scaling up application, wider commercialisation, and deployment (feasibility study, business plan), if necessary indicating the possible funding sources to be potentially used.

HORIZON-CL5-2023-D5-01-16: Developing small, flexible, zero-emission and automated vessels to support shifting cargo from road to sustainable Waterborne Transport

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 9.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Development and validation of a small zero-emission automated vessel concept which can support shifting cargo from road to water. The concept will take into account cargo types and navigation conditions (e.g. small waterways, bridges, locks and shallow coastal waters and estuaries).
- Quantification and assessment of the reduced costs and emissions and stronger intra- and intermodal competitiveness of waterborne transport through integration of zero emission

propulsion of automated vessels and transshipment into automated transport chains, internet of things and possibly urban logistics.

- Development of business models that benefit from a high degree of automation digitalisation, considering technical, safety, security and organisational aspects and when relevant smart on demand services.

Scope: Waterborne transport can transfer large freight volumes from road and as a result reduce emissions and decongest road infrastructure. There are large opportunities to increase waterborne freight, especially in coastal and inland or congested urban regions. This potential is particularly underdeveloped within smaller waterways, lakes, estuaries and intra urban regions and with the use of less developed ports which are not accessible for larger vessels.

Whilst projects addressing coastal transport and metropolitan inland waterway transport, including new autonomous waterborne feeder loop logistic services are underway, these remain at an early stage or are tailored to specific use cases which cannot be widely deployed.

Emerging energy efficient, zero-emission and automation technology can help fully exploit the potential of small-sized waterborne transport but are expected to be adopted to the needs of such vessels and the related additional transshipment.

Lower costs are needed for small waterborne transport to become more competitive with road transport.

Flexible, fully automated transport chain is expected to facilitate waterborne services to new and previously poorly accessible regions.

Shallow water depths of smaller waterways with confined conditions require a broad variety of intelligent vessel solutions, which are tailored to the regional requirements, the specifics of individual cargo types and load units, e.g., ISO containers, swap-bodies, unitized and palletized goods for urban transport etc.

Decarbonisation of propulsion systems is needed to address the challenges of climate change. Automated solutions need to also take into account unexpected recreational users of the waterways.

Research should develop versatile zero emission solutions for small, shallow water capable automated vessels that are also usable on different classes of waterway and/or coastal waters.

Developments should advance beyond the state of the art taking into account current and emerging developments concerning low-water designs, modular vessels, automation, digital communication and security battery electrification, charging, and propulsion systems.

Proposals are expected to address all of the following aspects:

- Development, testing and demonstration of the automated flexible vessel concepts with emission-free propulsion systems in a relevant environment. In addition, the optimisation of the logistics chain will be assessed through logistics modelling.

- Innovative automation approaches for substantial cost savings.
- Tailored propulsion arrangements for small, flexible and versatile vessels which are compatible with shallow water.
- Automated operations in multimodal logistics should be envisaged through further development and integration of single automated functions into fully autonomous systems such as; navigation and vessel command, machinery surveillance, maintenance, berthing, cargo handling, transshipment etc.
- Self-organised or remotely controlled fleet-wide coordination of operations, along with an integration of the vessels into land-based digital logistics processes.
- The development of new business models including a high degree of digitalisation and smart on-demand services. Consideration of key stakeholder behaviours, including retailers' and customers.
- Ensuring safety, cyber security and resilience of automations systems.
- Early communication and discussion with relevant regulatory and standardisation bodies.

HORIZON-CL5-2023-D5-01-17: Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 1.50 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for

	Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁷² .
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Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Development of inland waterway transport policies to ensure the implementation of green and digital, water protection and environmentally sound solutions.
- Identification of best practices and increase their take up and faster modernisation of the inland fleet.
- Building of a viable financial engineering instruments to support investments in zero emission, digitalised and connected vessels.
- Proposal of a European labelling system for EU waterways.
- Estimation of the potential modal shift to inland waterways transport with Impact of each Naiades III actions on modal shift.
- Provision of a knowledge exchange, discussion and promotion platform for implementing Naiades III innovative actions
- Working together with the Waterborne Technology Platform and the inland waterway transport sector; strengthen the coordination between national, EU and industrial research across the waterborne transport sector, the wider logistics chain in cooperation with relevant international organisations so as to increase the deployment of the solutions developed and provide input towards EU R&I and deployment programmes.
- With the direct involvement of end users' improvement of the environmental performance of inland waterways and contribute to future-proof; workforce, infrastructure, digital and automation developments which are compatible with a changing climate.

Scope: The European Green Deal and NAIADES III challenges require a breakthrough Action Plan for the innovative system change from a holistic perspective to achieve drastic emission reduction and modal shift targets. These elements lead to:

- a change in the ownership structure and business models (e.g. energy as a service, leasing),

²⁷² This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- intensive horizontal and vertical collaboration, vessels using (near) zero-emission technologies and energy carriers (e.g. batteries, fuel cell, synthetic fuels and clean combustion),
- standardised and modular hardware and ship design as well as advanced IT solutions for connected inland waterways transport,
- synchro-modal planning,
- safe and autonomous navigation and smart shipping.

Also, the required infrastructure, regulations, incentives need to be addressed. Finally, end user buy-in and commitment will be key to facilitate these changes.

Targeted follow up coordination and support activities are needed in the Inland Waterways sector, and in particular to support implementation of NAIADES III. These actions will address greening, and digitalisation and the leverage of the outcomes from related projects. In addition, actions should support a bridge between research, innovation and the buy in and deployment within inland waterways sector in coordination with the wider waterborne and logistics sectors.

A dedicated Coordination and Support Action will act as European platform and catalyst by bringing together the required expertise, disciplines and stakeholders. Synergies and collaboration with other sectors and transport modes will be crucial elements.

Proposals are expected to address all of the following aspects:

- Identification and analysis of barriers and opportunities for the development, implementation and take up of low and zero-emission innovations as well as digital solutions for the inland waterway transport sector in close cooperation with relevant projects and initiatives, including those targeting the broader waterborne transport sector. In this respect, a particular focus will be to decarbonise and improve the environmental performance of inland waterway transport, particularly within urban and protected areas as well as future-proofing infrastructure and ensuring compatibility with digital and automation developments within a changing climate.
- Development of an implementation plan, in close cooperation with the industry, which includes an assessment of the Total Cost of Ownership. Lessons learnt from frontrunners will be included in the assessment. In addition, the industrial commitment in terms of investments will need to be leveraged with additional resources, which might be available in the next Multiannual Financial Framework, aiming for a dedicated financial instrument for co-financing the deployment of zero-emission, automated vessels with innovative public-private collaboration models for deployment²⁷³.

²⁷³ Communication de la Commission: Future-proofing European inland waterway transport - NAIADES III action plan: NAIADES III Annex I action 33 "Facilitate the efforts of stakeholders and Member States to create a fund complementing EU and national financial instruments",

- The development and validation of a Digital Twin to support conclusions and recommendations on policy measures and regulations. The Digital Twin enables quantitatively simulating different scenarios and options to assess the contributions on modal share by the NAIADES III measures and emission reductions and the impacts for the various stakeholders involved.
- The consolidation of the Inland Waterways Transport (IWT) knowledge network, which was previously established with the support of H2020 and will end in 2023. The coordination and support action will build on the results of previous work and will reflect the multi-disciplinary requirements and complexity of the subject, coordinating with the wider waterborne, land transport and logistics communities. It will identify the appropriate measures and define the necessary means and tools.
- Develop further a RD&I roadmap and implementation plan, in coordination with the Waterborne technology platform, by integrating all stakeholders.
- Monitor the inland waterway transport RD&I project from relevant European programmes and their impacts, in coordination with the Waterborne Technology Platform.

This coordination and support action will ensure an active participation of key industrial stakeholders, the Waterborne Technology Platform, EU Member States/Associated countries' administrations, industry associations and river commissions.

Transport-related health and environment

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D5-01-18: Advanced transport emissions monitoring networks

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation

<https://ec.europa.eu/transport/sites/default/files/com20210324-naiades.pdf> and EP report P9_TA(2021)0367 "Towards future-proof inland waterway transport in Europe - European Parliament resolution of 14 September 2021 towards future-proof inland waterway transport.

	and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following expected outcomes:

Supporting the Zero Pollution Action Plan and its monitoring strategy by:

- Monitoring pollutant (including both exhaust and non-exhaust traffic related particles²⁷⁴) and noise emissions of road vehicles on specific sites in urban areas with high density traffic in order to feed multiple real time systems and databases for air quality and environmental noise monitoring, anti-tampering enforcement, market surveillance and policy support at local, national and EU level.
- Monitoring pollutant (including both exhaust and non-exhaust traffic related particles) and noise emissions around ports, rail stations or junctions, dry ports, and airports, allowing for instance to monitor and enforce the respect of fuel use mandates in specific protection areas, correct noise abatement procedures, aircraft type limitations, etc.
- Establishing real time maps and networks in at least eight cities with at least three traffic air quality and noise stations on each city (a minimum of 5 stations in ports and 5 stations in airports is required) capable of measuring noise and solid particle number (PN down to 10nm according to WHO recommendations) and other emerging pollutants and GHGs in addition to the currently regulated ones and the impact of nature-based solutions (such as line trees along the streets, green facades in buildings, urban parks etc.) for mitigating them.
- Supporting local, regional and national emissions and noise reduction plans (including dynamic ones based on smart traffic management systems, capable of influencing the behaviour of drivers and automated vehicles) by providing supporting real time data and integrating the impact of road, rail, port and airport traffic into the management strategy.
- Supporting health studies about the impact of ultrafine particles according to recent WHO guidance
- Stimulate citizen awareness and engagement in the Zero Pollution strategy (also through citizen science approach)

²⁷⁴ Like the brake and tyre wear emissions which are generated from non-exhaust traffic related sources such as brake, tyre, clutch and road surface wear.

- Providing recommendations concerning the use of nature-based solutions for mitigating urban air and noise pollution and contribute to the standardisation effort of sensing/monitoring technologies.

Scope: Transport emissions are a known cause of air and noise pollution in Europe, and therefore negative health impacts, particularly in urban environments. Road emissions play a significant part, but there can be important contributions by other transport sources if airports, ports, or rail stations with significant traffic from diesel locomotives are within or close to the city boundaries. Moreover, construction machinery can largely contribute to both emissions and noise where large building sites are present.

Long-term exposure to air pollutants from road traffic, railways and aircrafts can lead to serious health effects, such as sleep disturbance, cardiovascular diseases, metabolic disorders, annoyance, cognitive impairment and mental health problems. Noise pollution has its share of causing those health impacts and is an equally important environmental concern, likewise emitted by means of transport (road, rail, air traffic) and from sites of industrial activity. Besides the combustion engine, it can also be caused by aerodynamics or tyre-road or wheel-rail interactions. It adversely affects quality of life and well-being, prompting the need for seeking solutions to tackle these two forms of environmental pollution in order to reduce their harmful effects on human health and on the natural environment.

While some of these emissions are regulated, it has become apparent that the performance of propulsion and after treatment systems can change depending on use conditions or over time due to different causes (poor or even fraudulent design, tampering by the user, poor maintenance, catalyst degradation ...). Therefore, there is more and more interest to monitor these pollutant and noise emissions to the level of the individual vehicle and their cumulative effect at the city scale in order to provide a sound basis to understand the causes and to tackle, if needed, higher-than-expected emissions by enforcement or regulatory means.

Traffic-related particles can be distinguished into exhaust traffic related particles, which are emitted as a result of incomplete fuel combustion and lubricant volatilisation during the combustion procedure, and non-exhaust traffic related particles, which are either generated from non-exhaust traffic related sources such as brake, tyre, clutch and road surface wear or already exist in the environment as deposited material and become re-suspended due to traffic induced turbulence. It is estimated that exhaust and non-exhaust sources contribute significantly to total traffic related PM10 emissions, thus it is important to monitor both these categories of pollutant emissions, while differentiating their contribution to PN.

The Flagship on the contribution of transport to pollution in the 2019 call has included several topics addressing the development of technologies to monitor some of these emissions, and it is now important to transfer these technologies to the field and to integrate them in networks capable of 24/7 unassisted operation and data management and reporting for enforcement and fleet monitoring by cities and national bodies, and where appropriate shared with EU level bodies.

The design, testing and demonstration of these applications will be developed in cooperation with the involved cities, citizen associations, and authorities, to achieve the best use of monitoring data. Citizen science approach could be appropriate for these activities.

Projects are expected to install monitoring stations around at least 5 ports and 5 airports, allowing for instance to monitor and enforce the respect of fuel use mandates, correct noise abatement procedures, aircraft type limitations, etc. Projects should achieve synergies between the monitored cities, ports and airports.

At the same time, recent WHO guidance²⁷⁵ recognised the specific risks posed by nanoparticles and provided for the first time a quantification of what can be considered a low and a high concentration of particles in terms of numbers instead of mass. Guidance was also provided to widen the collection of data to ultrafine particles down to at least 10nm, in order to allow the performance of epidemiological studies and, in the longer term, the establishment of new limit values.

Moreover, emerging pollutants and greenhouse gases are increasing due to the deployment of new technologies. Nitrous oxide, for instance, is both a very potent GHG and a neurotoxic with negative effects also on liver and kidneys and is a by-product of several catalysts. Ammonia is also posing similar by-product issues, in particular for methane and SCR-equipped vehicles, by leading to high secondary particulate levels. Therefore, monitoring these and other chemicals and their synergistic effects is becoming more and more important to inform policy decisions and provide data for modelling and emissions inventories.

A specific topic in the 2020 Green Deal call²⁷⁶ foresaw the developments of measurement instruments and methodologies for ambient ultrafine particles and atmospheric particulate matter, their sizes, constituents, source contributions and gaseous precursors. The wider deployment of the results on a cross-European base, encompassing as many as possible different locations in terms of urban morphology and meteorological and pollution conditions is paramount for the validation of the system and for the establishment of an EU-wide network.

Establishing, or contributing to, national level databases of traffic related emissions could support population-based health studies about the impact of these emissions to human health. These databases could, for example, contain detailed information on traffic density, modal split, current composition of the respective road traffic fleet, especially in urban areas, and all health relevant pollutants, such as particles (PM10, PM2.5, PN), NO_x, benzene and UFP/EC/BC.

In consideration of the above, proposals should address all the aforementioned aspects and issues in order to achieve the expected outcomes.

²⁷⁵ <https://apps.who.int/iris/handle/10665/345329>

²⁷⁶ https://cordis.europa.eu/programme/id/H2020_LC-GD-9-1-2020 and <https://cordis.europa.eu/project/id/101037319> and <https://cordis.europa.eu/project/id/101036245> projects

Cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D5-01-19: Support for the organisation of EU-US symposia in the field of Transport Research

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 0.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 0.50 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁷⁷ .

Expected Outcome: Project's results are expected to contribute to all the following expected outcomes:

- Reinforced cooperation between the European Union (EU) and the United States of America (US) in the field of transport research and innovation.
- EU-US Transport Research Symposia organisation with high visibility, political and strategic relevance of the transport sector and of the EU policy in the field.

²⁷⁷ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- More effective links and exchanges between research and innovation stakeholders and policy makers from the EU and the US.

Scope: The EU and the US are both world leaders in transport research. On both sides, there is an increasing willingness to enhance and extend EU-US cooperation in the area of transport research.

An Implementing Arrangement between the European Commission and the US DoT was signed in 2013 for cooperative activities in the field of research, development, technology and innovation applied to all modes of transport. The purpose of this arrangement is to advance the EU and US cooperation and collaboration in R&I for all the four modes of transport, including multi-modal activities. To implement that arrangement, a Steering Group has been established, composed of DG MOVE and RTD officials for the EU side, to identify, elaborate and coordinate collaborative activities.

Within this context, EU-US Transport Research Symposia are to be co-organised on one side by the European Commission and on the US side, by the US DoT and the Transportation Research Board (TRB) on a yearly basis. Hosting of the Symposia's organisation is done on alternate years by the EC and the US.

The symposia promote common understanding, sharing of experience and best practices, efficiencies, and transatlantic cooperation within the international transportation research community, while accelerating transport-sector innovations in EU Member States/Associated countries and the United States.

Six symposia already took place in the last years addressing themes such as: 'Urban City Logistics' (Washington, 2013), 'Transport Research Implementation' (Paris, 2014), 'Automated Road Vehicles' (Washington, 2015), 'Infrastructure Resilience' (Brussels 2016), 'Decarbonizing transport for a sustainable future: mitigating climate change' (Washington, 2017), ' Socio-economic Impacts of Automated and Connected Vehicles' (Brussels, June 2018).

The aim of this action is to support the European Commission in organising the future annual symposia in 2024 (Washington), in 2025 (Brussels), in 2026 (Washington) and in 2027 (Brussels). Symposia are closed events with 50 experts -25 from the US and 25 from the EU- selected by US DoT and the European Commission respectively. Throughout the 3-day event, these experts are brought together to identify, discuss and elaborate strategic R&I recommendations related to the jointly chosen theme of each symposium by the US DoT and the European Commission.

The action will have to foresee the involvement of and collaboration with all the relevant European actors – researchers, industry, users, innovation leaders, etc. - representing the transport sector, in collaboration with the European Commission services in the relevant Directorate Generals. Consultation of key transport players in Europe including the different European Technology Platforms in transport and relevant Horizon Europe partnerships is foreseen, depending on the theme selected for the future symposia.

The action will have to work together with the two EC services to define the overall planning of each symposium, to support the drafting of a White Paper and conference proceedings reports, to design the structure the sessions of the event, to manage the expert’s contributions (25 EU experts, 3 of them being part of a planning committee with their US counterparts) and cover the travel and subsistence of the EU experts, communication material, etc. For those years when the Symposia is held in Brussels, to also manage the overall organisation of the symposia including selecting the appropriate location for the venue, covering the costs for the venue, the logistics, the travels and subsistence for the EU experts, communication material etc.

The list of the European experts that will be invited to the symposia will be proposed by the project after consultation with the stakeholders and will be finalised by the Commission.

The outcome of these symposia will help define a common vision for future transportation, lay the foundation for activities of mutual interest and benefit in all modes of transport, including enhancing EU international cooperation activities within the TRB International Committee (ICC).

Call - Clean and competitive solutions for all transport modes

HORIZON-CL5-2024-D5-01

Conditions for the Call

Indicative budget(s)²⁷⁸

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²⁷⁹	Indicative number of projects expected to be funded
		2024		
Opening: 07 Dec 2023 Deadline(s): 18 Apr 2024				
HORIZON-CL5-2024-D5-01-01	IA	15.00	7.00 to 8.00	2
HORIZON-CL5-2024-D5-01-02	RIA	15.00	4.00 to 6.00	3

²⁷⁸ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²⁷⁹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

HORIZON-CL5-2024-D5-01-03	RIA	10.00	Around 5.00	2
HORIZON-CL5-2024-D5-01-04	IA	17.00	7.00 to 8.50	2
HORIZON-CL5-2024-D5-01-05	RIA	10.00	4.00 to 5.00	2
HORIZON-CL5-2024-D5-01-06	IA	10.00	Around 10.00	1
HORIZON-CL5-2024-D5-01-07	RIA	17.00	4.00 to 5.00	4
HORIZON-CL5-2024-D5-01-08	RIA	21.00	3.00 to 5.00	5
HORIZON-CL5-2024-D5-01-09	RIA	3.00	Around 3.00	1
HORIZON-CL5-2024-D5-01-10	RIA	16.00	Around 16.00	1
HORIZON-CL5-2024-D5-01-11	RIA	15.00	Around 7.50	2
HORIZON-CL5-2024-D5-01-12	IA	15.00	Around 7.50	2
HORIZON-CL5-2024-D5-01-13	IA	6.00	Around 6.00	1
HORIZON-CL5-2024-D5-01-14	IA	15.00	Around 7.50	2
HORIZON-CL5-2024-D5-01-15	IA	7.70	Around 7.70	1
HORIZON-CL5-2024-D5-01-16	CSA	0.85	Around 0.85	1
HORIZON-CL5-2024-D5-01-17	CSA	1.50	Around 1.50	1
HORIZON-CL5-2024-D5-01-18	RIA	7.00	Around 3.50	2
Overall indicative budget		202.05		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.

<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Zero-emission road transport

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D5-01-01: Smart, low-cost pervasive stationary slow charging and bi-directional solutions synergic with the grid for EV mass deployment (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 7.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL7-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Project results are expected to contribute to all the following outcomes:

- Development and demonstration of innovative, interoperable, efficient, low-power smart and bi-directional on-street charging, removing barriers to EV user acceptability in

densely populated areas. User acceptability should be quantifiably improved from technological, investment costs and costs of charging point of view.

- The proposed innovative solutions should be conducive to optimise efficiency and reduce costs, but ideally should not be visually and physically intrusive, or these aspects should be kept to a minimum level, given the high level of expected deployment that would create problems for pedestrians and other road users.
- Development of an analytical methodology including representative models (replicable at an EU-wide scale) to ensure an efficient planning for the mass deployment and integration of public (and where applicable private) EV charging infrastructure²⁸⁰, satisfying concrete user needs (in particular for night charging of L, M1 and N1 vehicles and their opportunistic day charging) and making it compatible as much as possible with existing low voltage grid and power system capabilities.
- Quantifiable improvement of related business models and gaps for users compared to current State of the Art, additionally also including considerations for less densely populated areas.
- Development of socio-cultural databases at city, regional and national level comprising daily charging habits, practices, and ideas of different community clusters (including individuals with special needs) and their integration into charging and planning tools, to support the determination of the most efficient and most accepted charging solutions. These developments should interact with the work of Sustainable Transport Forum²⁸¹.
- The identification and analysis of potential regulatory aspects and barriers for relevant standardisation activities via common, interoperable and open standards, protocols and digital services.
- Deployment of multilevel systemic architecture and solutions for smart and bi-directional charging power management that will increase RES penetration as well as enhance the grid capacities and power system resilience by alleviating grid congestions and levelling off the load curve.

Scope: Future charging infrastructure deployment should be ubiquitous, and should parallel, with a certain level of anticipation the growth of EV sales. Associated charging solutions should enable seamless processes that are easy, fully interoperable across European country borders and available at any time. The aim of this topic is to enable and improve massive smart on-street low-cost charging of EVs as well as improving the overall efficiency of power supply to the grid, including a space-and-time-oriented prediction and control of the global charging power demand, also enabling and improving smart home and office charging that could be explored by proposals to complement the on-street charging solutions.

²⁸⁰ Considering, where appropriate, deployment targets under the Alternative Fuels Infrastructure Regulation (AFIR) and Energy Performance of Buildings Directive (EPBD) proposals

²⁸¹ https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/sustainable-transport-forum-stf_en

Proposals are expected to address all the following aspects:

- Guarantee an exhaustive coverage of high-efficiency, low-power, low-cost on-street smart charging points considering grid infrastructure and capacity, optimisation of civil works and grid requirements for services and charging needs, including the parking patterns (charging on long- and short-term parking spaces) to reduce the need for additional buffers to stabilise the grid.
- Address users' needs and requirements in socio-cultural contexts of different communities to incorporate daily habits, practices and ideas into the design and development of people-friendly infrastructure with emphasis on public charging (also considering smart use, while connected, of energy consuming convenience functions like cabin and battery pre-heating and cooling).
- Use statistical models of parking, traffic and grid configuration and energy flows to predict and support power supply planning on a larger scale (e.g. at least regional), along with methodologies and demonstrations to derive or calibrate such models on the basis of real traffic and behavioural data.
- People centric applications equipped with the analytical capability and Human Machine Interfaces (HMI) for friendly access and use, that support the interactions related to the ratio between location, power (and its guaranteed minimum) and price for prompt decision making or pre-allocation of charging stations in line with users' charging preferences and vehicle state of charge, also allowing charging point operators to predict power demand.
- Support and demonstration of smart and bi-directional operation in overnight publicly accessible environments to accommodate demand for long-term charging, and meeting some of the requirements of opportunistic charging types, motivating the people to optimally charge (maximising the use of renewable power) and promoting the development and use of interfaces with customized vehicle charging technology which can be preconditioned and set-up by the driver, including the pre-allocation of charging points.
- Development of innovative optimisation functions exploiting real-time access to battery information such as state of health, state of charge, capacity and power set point, which should be provided respecting any GDPR and data disclosure terms to the owners, users or other stakeholders in the value chain, such as building energy system managers, mobility and logistics service providers and electricity stakeholders.
- The developed solutions are expected to be provided on non-discriminatory terms between users and classes of users and allow the choice of the e-mobility service providers, so as to avoid consumers lock-in with a single e-mobility service provider, affiliated to specific vehicle manufacturers.

- Optimise the use of energy resources and infrastructures to cater not just for private mobility usage but also integrating opportunity use of the same infrastructure by other light duty captive fleets if their needs are compatible with the low power level.

This topic requires the effective contribution of Social Sciences and Humanities (SSH) disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. Furthermore, in order to achieve the expected outcomes, social innovation should be considered.

The selected projects are invited to participate to BRIDGE²⁸² activities when considered relevant.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-02: Integration and testing of next generation post-800V electric powertrains (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Next generation powertrain architectures using voltages 1200 V and above might contribute to the achievement of safer, higher-performing and more sustainable end products to serve high volume markets. A holistic approach to the whole powertrain

²⁸² <https://www.h2020-bridge.eu/>

should contribute to determining the optimal next generation voltage level. Project results are expected to contribute to all the following outcomes:

- Very fast charging, ultra-efficient electric vehicles (EVs) for broad mass markets, taking into account volume effects and cost optimized architectures for future markets.
- A cost reduction of a minimum of 20% of power electronic modules and inverters for a given power, as well as for the whole powertrain, should be demonstrated (in comparison to the cost of the best current-generation or close to market components and architectures at proposal submission time).
- Fast charging of a mass market C segment vehicle demonstrator from 20 to 80 percent in 10 minutes with currently available 350kW chargers.
- Practical range increases over travel time (~20 percent increase with the same battery weight) with overall higher efficiency and easier thermal management of the whole powertrain allowing reasonably sized, lower cost and environmentally friendly batteries to perform long trips conveniently.
- Significant advancements in efficiency (reduction of losses by 25%) versus the state of the art of the targeted application with a special attention to partial load condition in EVs and charging stations alike.
- Backwards compatibility and reliability aspects.
- Improved application safety and robustness that contribute to a better user buy-in.
- Improved resource efficiency with better lifecycle impact and recycling capability → contributing to a circular economy approach.

Scope: In the last decade, the more and more demanding power and application requirements led to an increase of board net HV voltage from an initial 400V level to 800V in the latest electric vehicles, already trickling down to lower categories. Significantly higher voltages (indicatively, in the 1200V region) may be the next logical step and become standard in the next decade, providing benefits in terms of efficiency, copper use and weight. If not properly managed, they could have a constraining impact on the overall architecture especially in terms of DC charging and efficiency for low power use. Thus, new challenges for the powertrain arise in the areas of the motor, battery, cabling, couplers etc. as well as in electromagnetic compatibility and the development and integration of new power semiconductors.

To successfully address the expected outcomes in the constant drive to improve efficiency and performance while increasing affordability, proposals are expected to address several of the following aspects capable of demonstrating the achievement of the intended objectives at system level:

- Assess in a holistic way the positive and negative impacts of higher voltage levels at vehicle and powertrain level, defining the best option for the post-800V EV generation.

- Development and integration of power-electronic components with new concepts for component miniaturisation and modularity. Also, solutions that can transition rapidly from modular to integrated systems need to be identified, depending on demand and eco-balance.
- Topologies adapted to advanced wide-bandgap semiconductors and new materials, leading to higher power density.
- Modular powertrain platforms, with the aim of coming closer to a full mechanical, electrical or thermal integration of the three main systems (electric motor, power electronics systems and battery pack) benefitting from the smaller sizes and cooling demands due to higher voltage.
- Defining suitable testing and validation procedures on component, powertrain or vehicle level and demonstrating them on a suitable use case. Furthermore, the projects should identify and analyse potential regulatory aspects and barriers to contribute to a definition of common EU standards for system validations.
- Small-sized, ‘ready for integration’ power modules at the best system fitting position (e.g. e-motor or battery) for greater design flexibility while optimizing costs.
- Packaging and coupler solutions e.g., substrates, moulding epoxy, electrical interconnections, adapted for higher voltages, increased isolation demands, high-frequency switching, frequent thermal cycling, elevated temperatures etc.
- Heat spreading technologies for short power pulses/ heat dissipation approaches for long duration pulses, long acceleration phases.

Exploitation of outcomes, and knowledge from ECSEL/KDT partnership²⁸³ projects should be foreseen where applicable, as well as feedback in terms of future needs to achieve the project outcomes should problems be encountered. The development of the needed semiconductors, however, is not part of this topic's funding, and the proposal is expected to specify the components that the involved semiconductor suppliers guarantee to provide for the research activities.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-03: Advanced battery system integration for next generation vehicles (2ZERO Partnership)

Specific conditions

²⁸³ <https://www.kdt-ju.europa.eu/>

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve at least TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to address all the following outcomes:

- Novel and innovative approaches to battery integration into vehicle structure focusing on solid state generation-4 cells, including modular systems capable of temporary expansion for long trips in small and medium sized cars without a permanently installed large battery.
- Improvement of the fast-charging capabilities up to at least 3C, and aiming for higher capabilities for high energy cells, independent of battery topology in the vehicle.
- Increase gravimetric energy density of the integrated pack (excluding contributions by cell chemistry) by at least 25%, and volumetric energy density by 70% from 2023 State of the Art).
- Reduced battery system cost considering the functionalities of the vehicle structure (excluding contributions by cell chemistry, below EUR 100/kWh for systems used in light duty Electric Vehicles (EVs) by 2030). Safety aspects of the prototype cells need to be considered.

Scope: In order to reduce the overall cost of electric vehicles modularity, scalability and the development of strategies for their implementation will become increasingly important in the future. With the expected introduction of new cell technologies, specific choices for connections, cooling system concepts and materials for housing will play a crucial role in the battery performance improvements and the battery integration in the vehicle structure. The development and integration of structural, thermal and mechanical aspects (at different levels of modularity or integration) will need to be improved, while exploiting the intrinsic advantages of innovative type of cells.

Proposals are expected to address all the following aspects:

- Structural battery pack design and integration in the vehicle considering trade-offs in all important areas such as energy density, thermal management, maintainability and reparability, crash safety, energy density, production cost, second life, dismantling and recycling processes.
- Smart thermal management systems for both heating and cooling, with smart interfaces to the vehicle systems (including energy-efficient preconditioning, using internal or external energy sources whilst charging), contributing to further improvements in the overall battery system efficiency and optimizing the overall battery system, also in consideration of passenger comfort.
- Novel cooling system concepts exploiting the reduced thermal constraints of generation-4 cells ensuring minimal impact on system mass and costs, especially taking into account the thermal and electrical interfaces of different possible cell geometries (e.g. pouch, prismatic or cylindrical).
- Take into account the development of the technical communication channel for the access and exchange of relevant data types from the battery management system (BMS), such as state of charge (SoC), state of health (SoH), temperature (T) or voltage (V) that are essential to ensure efficient and secure recharging processes.
- Digital twin of thermal behaviour of EV and battery for optimal chemistry / energy management and safety assessment of batteries.
- Enhanced communication between battery and vehicle control units for a more efficient battery operation by synchronizing ECUs of the BMS and the EV (links are expected to be established with projects funded under topic HORIZON-CL5-2023-D5-01-02: Innovative battery management systems for next generation vehicles).

Projects should take into account the access to battery information as defined in the proposal for the Renewable Energy Directive COM(2021)557 of 14 July 2021.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-04: Integrated flexible multipoint megawatt charging systems for electric truck mass deployment (2ZERO Partnership) (2024)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 7.00 and 8.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

	selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 17.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all the following outcomes:

- Improved designs, architectures and models of interoperable multipoint megawatt charging systems for future mass deployment of Heavy-Duty trucks and concepts for managing their grid impact.
- Tools to identify the energy needs and the charging profiles of the electric vehicles that are expected to charge on megawatt charging systems.
- Integrated and flexible interaction control and energy management based on interoperable and open protocols between on-board and off-board charging-related components and the local grid demand flexibility providers, renewable electricity generation and energy storage systems,
- Improved modelling of the optimal geographical locations for large-scale megawatt charging hubs for Heavy and Medium Duty Vehicles and multiplexed Light Duty passenger/commercial vehicles usage at traffic peak times while also considering the relevant challenges to the grids and their mitigation with smart charging concepts, in consideration of locally available energy grids capacities and local energy storage.
- Tools and services for planning, operation, availability and reliability of the overall megawatt charging multipoint hubs from users’ perspectives (vehicle driver, fleet manager) and grid operators and energy providers.
- Highly energy efficient megawatt-charging hubs, also with optimal utilisation of multi-point megawatt charging stations for HDV-users but also considering other types of vehicles.
- The proposed concept for a charging stations with at least four flexible megawatt charging points of 1MW or more will be demonstrated at the end of the project, each of these points being in turn also capable of recharging at least four lighter vehicles.

Scope: Next generation battery electric vehicles need to be more energy efficient and affordable, which means to keep battery size to the practical minimum. Megawatt charging is then required to meet the demand for long operational range with even shorter charging times. Ultra-high-power charging on-board and off-board sub-systems design is, as a first step, covered in topic HORIZON-CL5-2022-D5-01-08. The present topic covers their evolution towards multi-charger hubs that cater for a widespread deployment of these vehicles on the 2030 horizon. Limited on-board systems optimisation may be included if properly justified. At the same time each charger in these charging hubs will be usable for multiple lighter vehicles with lower power (150-350 kW) during peak times such as weekend or holiday periods, when demand from heavy duty vehicles may be lower. This will also require concepts for topologies capable for accommodating one heavy vehicle or 4-6 light vehicles in each charging spot.

Proposals are expected to address all the following aspects:

- Consider typical demands along significant TEN-T corridors, including under severe weather and peak conditions, as well as opportunities for sharing and balancing power supply within studied areas, locations of logistics terminals and truck stops with nearby depots for overnight charging of trucks, buses, and construction machines, car-parking etc.
- Input from EU Member States/Associated countries' maps with aggregated charging demands and expected high power charging station localisations as well as input from grid operators on power system local and regional conditions is also expected. Such terminals/ hubs for charging should offer charging on non-discriminatory basis.
- Particular attention should be paid to the real needs of end users, including optimised infrastructure locations, its reverse impact on the traffic flow, ease of use and interoperable protocols that do not hinder universal use across different countries; the identification and analysis of potential regulatory aspects and barriers for relevant standardisation activities is encouraged.
- The developed tools should have the capability to map the optimal locations for a fast and high-power charging infrastructure (already built-up logistics hubs, truck service centres, truck and bus depots, and for new ones also considering the permitting process), offering planning information including to the developers of the targeted infrastructure. For optimisation of the overall system use, services and tools should be developed keeping into account on-board EV system characteristics.

Topic is open to international collaboration, in particular regarding interface specifications (e.g. with the USA).

This topic implements the co-programmed European Partnership on 'Towards zero emission road transport' (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership 'Towards zero emission road transport' (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-05: Advanced digital development tools to accelerate the development of software defined vehicles that enable zero-emission mobility (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Advanced digital tools can enable the mobility industry to efficiently develop and operate software-defined electric vehicles that are key for achieving sustainable mobility solutions. Core functions of the electric powertrain or vehicle dynamics are primarily enabled and controlled via software. Function updates are at the fingertip of the end-users to offer maximum customer benefits and satisfaction. Such next generation modelling and simulation tools & methods empowering e.g., software-driven development, automated engineering as well as credible simulation pave the way to make mobility safer, more sustainable and more comfortable in a new way.

Project results are expected to contribute to all of the following outcomes:

- Design and validate digital tools for the automotive industry for enabling best possible combination of digital development and digital operation for innovative zero-emission solutions enabling up to 20% energy consumption reduction by e.g. deploying always latest software-driven energy saving functions becoming available during vehicles entire lifetime and to ensure performance, security, safety and reliability by design.
- Increase speed of innovation by optimising the utilisation of data (engineering, operational, infrastructure data etc.) in an effective and efficient way (synthesis and utilisation of data).

- Contribute to the development of solutions for reliable ‘virtual’ decision-making based on digital twins and for enhancement of the credibility of simulations based on process and artefact quality measures, as well as KPI-driven quality assurance and traceability.
- Method and tools for reliable modelling and simulation of total vehicle systems including its environment.
- Significantly enhance the capabilities in design, development and application of “software-defined” EV and thus strengthening the competitiveness of the European automotive industry.
- Improve product quality, improve decision making efficiency, quality, and exploiting operation data and thus contributing to the reduction of the overall development time.

Scope: The data driven development of software-defined functions and systems of EVs (e.g. in context of battery and e-motor control, predictive eco-driving functions or control of vehicle dynamics, as well as comfort) requires the use of improved tools across domains (e.g. mechanical, dynamic, electrical, and acoustical) and scales (from component to vehicle in a mobility scenario) as well as a deep understanding of the vehicle operation in real life.

However, the current development and design framework does not allow such complex software-defined functions and systems to be addressed in an integrated manner, resulting often in solutions optimised for a specific operating point that is only partially representative of real use conditions and lacking the resource-efficient reuse of these solutions across multiple vehicle platforms. Moreover, the development of vehicles that are constantly capable to adapt during lifetime (e.g. by remote programming capabilities) is also not sufficiently enabled. As such the scope of this call topic is expected to go far beyond today’s product development as addressed in previous Horizon 2020 topics (e.g. H2020-GV-2018 “Virtual product development and production of all types of electrified vehicles and components”).

In order to fully exploit the potential of software-defined EV functions and vehicles, an advanced dedicated digital development framework is needed. Proposals under this topic are expected to address all of the following aspects:

- Design and validation of robust digital tools to efficiently and effectively develop complex EVs that are increasingly software-defined.
- Advanced methods for development of trustworthy (24/7 available, secure, safe) software-defined EV solutions.
- Promoting the use and adaption of conceptional tools and demonstrate integration into development frameworks for virtual approval (early demonstrators) that are applicable to all EV types considered in 2ZERO (from L-category to Heavy Duty vehicles).
- Concepts enabling the feedback to and use of all types of data (e.g. engineering data, real-life operational data of EVs) in the product development of software-defined vehicle functions including automated update of the applied digital tools and models.

Close collaboration is expected between selected projects under this topic and modalities need to be outlined in the proposal.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-06: New designs, shapes, functionalities of Light Commercial Vehicles (2ZERO Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL7-8 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

- Develop and demonstrate new and innovative mission focused and efficient Light Commercial Vehicles (LCV) battery electric concepts to address new requirements (e.g. growing of e-commerce overall and in segments such as groceries or cold chain products, urban logistics consolidation schemes) from zero emission logistics processes in cities increasing the affordability and scalability of the proposed solutions.
- Demonstrate scalable zero emission real life operations in the city environment including charging and building synergies between the new LCVs and zero emission Heavy Duty Vehicles operations to address user needs in a sustainable and safe manner.
- User and mission-centric definition of requirements on vehicles, infrastructure and system from mobility operators and logistics companies considering new and innovative solutions.

Scope: The main objective of this call is to deliver new urban optimized light commercial zero-emission vehicles with a focus on goods transport, that are affordable, safe, sustainable and reliable and with a strong engagement from freight services users and fleet owners in the definition of requirements and testing. The focus will be to identify and overcome the main barriers for the development of new LCV concepts for urban and sub-urban logistics and freight mobility. Proposals are expected to address all of the following aspects:

- Engage with users of the vehicles, define requirements, expectations and potential developments that may influence future demand for these vehicles as well as considering the integration of vehicles in existing and future charging infrastructures.
- Develop and demonstrate new designs, shapes and functionalities of Light Commercial Vehicles to meet current and future needs for commercial delivery of goods, including safety aspects.
- Demonstrate the developed vehicles and operational concepts considering current and future demands for these vehicles in a growing e-commerce market for deliveries and returns of parcels, groceries and refrigerated goods and addressing the challenges holistically (i.e. by demonstrating the concepts in actual current or new logistics operations including charging and addressing requirements in cities with extended zero emission zones).
- Establish synergies and links with new logistics concepts developed in R&I projects focused on logistics operations and innovative concepts (such as the Physical Internet).
- Demonstrated vehicles and operational concepts are expected to target important markets with the potential for the largest environmental impact.
- Optionally and additionally, concepts for demonstration of the combined usage of people and freight vehicle operation, fleet utilisation optimisation in dense-urban areas might be included.
- Development of appropriate operational and control strategies during acceleration and braking to reduce secondary brake and tyre particle emissions, optimise energy recuperation and further reduce environmental impact in urban environments.

This topic implements the co-programmed European Partnership on ‘Towards zero emission road transport’ (2ZERO). As such, projects resulting from this topic will be expected to report on the results to the European Partnership ‘Towards zero emission road transport’ (2ZERO) in support of the monitoring of its KPIs.

Aviation

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D5-01-07: Accelerating climate neutral aviation, minimising non-CO2 emissions

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 17.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.

Expected Outcome: Project results should focus to the minimisation of aviation non-CO2 emissions. Project results are expected to contribute to at least three of the following expected outcomes:

- Primarily, further increase the scientific understanding related to the impact of aerosols on clouds as well as the contribution of aviation NOx emissions to climate change.
- Investigate further on how to support potential policy measures identified in the EASA study²⁸⁴, including whether they are proportionate, feasible and reduce the overall climate impact (CO2 and non-CO2 emissions).
- Perform detailed analysis of optimal relation between costs and climate.
- Perform engine gas and particle emissions characterisation, when data is incomplete or unavailable.
- Perform flight tests and demonstrate the benefits and fuel burn trade-offs of avoiding climate sensitive regions.
- Perform hydrogen and aviation drop-in fuel research with an eye towards reducing further non-CO2 emissions.

²⁸⁴ COM(2020) 747 final - Updated analysis of the non-CO2 climate impacts of aviation and potential policy measures pursuant to EU Emissions Trading System Directive Article 30(4).

- Develop further real-time decision-support software for airlines and ATM, to predict the location and global warming impact of contrail and contrail cirrus formation.

Scope: EU-studies show that approximately 50-75% of aviation's climate impact is caused by non-CO2 emissions. It is because of their local geographical character, their dependency on atmospheric phenomena, the incomplete understanding and uncertainty as well as operational trade-offs that non-CO2 emissions have been less-targeted so far from international and European regulatory measures. Recent studies show that cost-effective mitigation measures are possible, provided that focused R&I actions together with flight tests resolve the final uncertainties. However, today any avoidance that increases CO2 emissions, even at a net reduction of overall climate warming impact, introduces a complex policy issue of mitigating short-term versus long term climate effects.

Recent EU and National-funded research activities (i.e. FP7-REACT4C, SESAR-FLyATM4E, ALARM, SINOPTICA, DLR-WeCARE, H2020-ACACIA, HE-BECOM) characterized better the contrail formation and provided more insight in the aviation NOx emissions and ozone formation. The studies also showed that if aircraft operations are only optimized for fuel use, they may have an increased climate impact, since non-CO2 effects may compensate the reduced warming from CO2 savings.

Avoiding climate sensitive regions has a large potential in reducing climate impact at relatively low costs without causing significantly more CO2 emissions that outweigh the overall climate effect. The integration of data analytics and weather forecasting into advanced decision-support software tools that are able to predict real-time the contrail formation as well as propose alternative paths, are well in-line with the scope of this topic. This topic aims to integrate and provide clear operational guidelines supported by validated flight tests. Engine gas and particle emissions characterisation, when data is incomplete or unavailable, is in-line with the scope of this topic.

As a follow-up of EASA study, on non-CO2 climate impacts, and for the standardisation in view of safety considerations and future certification, the involvement of EASA is necessary (e.g. as part of the steering group), as well as the coordination with ICAO relevant groups (CAEP).

Synergies with SESAR3 should also be exploited – in view of the relevant topics in the SESAR3 JU bi-annual work programme 2022-2023. Furthermore, international collaboration for research and Air-Traffic Management should be sought (e.g. SESAR/NextGen).

Synergies may also be considered with the Digital Sky Demonstrators, including in particular flights for demonstrating green trajectories or equipped with sensors to collect data for the assessment of the non-CO2 impact on aviation. Finally, synergies with Destination Earth should also be sought.

**HORIZON-CL5-2024-D5-01-08: Competitiveness and digital transformation in aviation
– advancing further composite aerostructures**

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 21.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ²⁸⁵ .

Expected Outcome: Project results should focus on advancements in composite aerostructures and deliver new tools and processes in support of the European aviation supply ecosystem. Project results are expected to contribute to at least two of the following expected outcomes:

- Advanced composite technologies, with emphasis on new designs, high-volume sustainable manufacturing with integrated inspection, sustainable and free of toxic substances, recycling and circularity, structures safety requirements (EMC/lighting protection, ice formation, fire, fatigue, crashworthiness and ditching) and additive manufacturing of the new generation of composites - for aerostructures and propulsion.

²⁸⁵ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Breakthrough technologies in coupled aerostructures-systems-propulsion integration.
- Cost-competitive maintenance and repair of composite aerostructures, including Structural Health Monitoring (SHM).
- Advancements in physical and digital research infrastructures, with emphasis on aerostructures for all aircraft configurations with emphasis on synergies with the three Clean Aviation (CA) Strategic Research and Innovation Agenda (SRIA) thrusts, with an eye towards virtual certification.

Scope: The proposal is expected to develop further advanced composite design and manufacturing technologies that have potential to contribute to the digital transformation of the European aircraft supply chain.

The proposal is expected to give emphasis to cost-competitive and sustainable manufacturing, characterisation, maintenance and end-of-life solutions of composite aerostructures. Composite multifunctional and multi-material innovations that result from closer aerostructures-systems-propulsion integration are expected to be addressed.

All developed advanced composite technologies should be scale-demonstrated in relevant challenging industrial cases.

The proposal should seek to exploit synergies with Clean Aviation (and big demonstrations in the second phase of the partnership). The retained proposals, should, during the implementation phase, regularly exchange information with the Technical Committee of the Clean Aviation partnership.

HORIZON-CL5-2024-D5-01-09: Impact monitoring of EU Aviation R&I

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 3.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results should deliver an impact monitoring toolbox, including preliminary impact assessments, of the European aviation research and innovation - integrating the impact of all Horizon Europe relevant aviation R&I actions along its three pillars, excluding any actions beyond technologies and optimised operations (i.e. use of sustainable aviation fuels and market-based measures). Project results are expected to contribute to the following expected outcome:

- Deliver a toolbox, including preliminary impact assessments, that will be the reference choice for the definition and assessment of environmental, climate and competitiveness policy options of future European aviation R&I and regulatory measures (e.g. be used as the reference software to support future European Commission Impact Assessments) and assist EU Member States/Associated Countries, the European Commission and EASA in ICAO Working Groups and other International regulatory agencies. The toolbox, should also be able to perform trade-off studies, address the most cost-effective policy options as a function of time (towards up to 2070) and allow policy makers, industry and scientists to take informed decisions.

Scope: The proposal is expected to build on and improve an already established reference European toolbox (e.g. developed in retained proposal(s) from HORIZON-CL5-2022-D5-01-14) able to assess the impact of European aviation R&I, which is deployed to perform impact assessments of European relevant aviation R&I actions in Horizon Europe. The European Aviation R&I policy, and aviation policy at large, need a European capability (as open-source as possible) to assess what has been achieved and provide forecast analysis of the expected outcome of technological, operational measures. The toolbox, through its impact assessments, should provide insight that will be used in the communication of the impact and achievements of European, National and private aviation R&I investments.

The toolbox should:

- incorporate methodological, science-based and validated models that can be traced;
- pay particular attention – beyond CO₂ emissions - to non-CO₂ emissions and climate-sensitive regions as well as address interdependencies (e.g. noise in the airport vicinity);
- integrate and make use of existing toolboxes developed in previous EU R&I Framework Programmes (e.g. TEAM_PLAY, CS2-TE);
- be able to set the level of fidelity for aircraft technologies and air transport system, based on available data;
- be aligned with the methodology, assumptions, criteria, and required data for seamless data exchange with the Clean Aviation and SESAR 3 partnerships. The Commission will further take into consideration other Horizon Europe impact assessments and coordinate it with the Clean Aviation Technical Committee and SESAR 3 Scientific Committee.

The participants should work closely together with the relevant European Commission Services, the European Union Aviation Safety Agency, the Clean Aviation and SERAR3 European Partnerships as well as the European Environment Agency.

HORIZON-CL5-2024-D5-01-10: Towards a flying testbed for European leadership in aviation

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 16.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 16.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Projects should contribute to Europe's industry lead the twin transitions towards climate neutrality and digital leadership. The project is expected to deliver on all of the following expected outcomes:

- Design of concepts and validation of an experimental aircraft that will test, validate and accelerate radical new technologies and aircraft configurations that go well beyond the state-of-the-art;
- Deliver feasibility studies of the targeted aircraft concept, towards a preliminary design review, making use of sound/proven advanced simulation and modelling techniques;
- Deliver detailed technical roadmaps that demonstrate the path towards a flying test bed. Such roadmaps should include a needs and gaps analysis in terms of Technology Infrastructures with respect to radical aircraft configurations and related technology validation and certification;
- Provide a preliminary implementation and execution plan for the targeted aircraft concept, including a business and operating model.

Proposals may also address any of the following expected outcome(s):

- Address the impact on the air transport system of the targeted aircraft concept. Depending on the chosen concept, this may include Air Traffic Management, Safety and Security (including Cyber), New business models, Unmanned Aerial Systems, societal acceptability and impact, noise and quality of life, aircraft end-of-life aspects;
- Address sustainable and agile design, digital manufacturing methodologies and technologies, as well as the promotion of systemic circularity throughout the value chain;
- Provide a preliminary labour market analysis, including skills and education needs, needed for the development and full-scale commercial production of the concepts;
- Address the critical dependencies of aviation on imported fossil fuels and critical materials, contributing to a significant reduction of overall Europe's dependencies²⁸⁶ and promotion of European resilience and competitiveness;
- Propose new approaches to shorten the time to market, such as through digitalisation of key processes, virtual certification techniques, open innovation, etc.

Scope: Faced with the urgent imperative to decarbonise aviation, the industry is expected to be prepared to change from the current traditional aircraft designs evolved over decades and move to new sustainable disruptive solutions across its complete portfolio of aircraft for the long-term.

A fundamental steppingstone to achieve the long-term goal of developing more sustainable disruptive solutions are experimental aircraft which have shown over the decades to have a lasting influence on the industry's long-term design choices and competitiveness. Experimental aircraft have been essential to de-risk and understand the possibilities of new solutions before irreversible decisions need to be made.

In addition, experimental aircraft programmes have an agglomeration effect on key skills and facilities throughout the research and development value chain, as well as providing a notable source of inspiration to multiple generations of future aspiring aerospace professionals and society in general.

Therefore, this type of endeavour is an ideal opportunity for a pan-European approach to lead the way and build upon the findings from the H2020-RINGO²⁸⁷ project where a strong need was found for sub-scale to full-scale flying demonstrators for validation and demonstration of new configurations and concepts. These flying test beds should focus on innovations that go well beyond anything currently addressed in Clean Aviation and should focus on generating impact in 2050 and beyond.

²⁸⁶ <https://ec.europa.eu/social/main.jsp?catId=1223&langId=en>

²⁸⁷ <https://cordis.europa.eu/project/id/724102>

This topic aims at significantly reinforcing the EUs leading position in Aerospace innovation through radical, experimental innovation needed for zero-emission aircraft of the future. By creating a flying, experimental test bed the twin transition of Europe towards a climate neutral and digital society will be accelerated and EU global industrial leadership will be strengthened. The European flying testbed, the E-Plane will enable disruptive ideas to be tested and will shape the sustainable, zero-emission air transport of tomorrow.

The concept aircrafts are also expected to address long-range (>4000km) missions, where new radical configurations are still needed to be explored to fill gaps for implementation in time to help ensure global aviation carbon neutrality by 2050. To allow for new, disruptive business models, no passenger range or payload is prescribed. However, future competitiveness of the concept should be addressed.

This topic should contribute to the European Skills Agenda The topic addresses primarily to RTOs/Academia/SMEs, with guidance from suppliers and aircraft integrators. One retained project for this topic will allow meaningful validation and feasibility studies and common platform.

Waterborne transport

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D5-01-11: Achieving high voltage, low weight, efficient electric powertrains for sustainable waterborne transport (ZEWTP Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Demonstrate increased performance, efficiency, feasibility and reliability of battery installations in high voltage on board distribution systems and thereby facilitate the greater deployment of battery electric shipping.
- Development and validation of battery real-time condition monitoring systems with predictive analytics integrated algorithms.
- Demonstration of high-capacity energy storage systems above 1 MWh directly interfaced to medium voltage AC (3.3 kV or above) or DC (above 1 kV) power systems, by modular approaches.
- Demonstrate the feasibility of an innovative low weight, high-energy density battery concept in demonstrators, considering maritime and inland waterway transport applications, including demonstration of on-board battery safety.
- Efficient modular redundant conversion systems with low voltage battery modules at floating potential and insulation for cost effective integrated battery modules and conversion systems are designed.
- Evaluation of sustainable life cycle management of electrical energy storage systems.

Scope: The voltage level of battery installations on-board vessels is typically limited and within the regulations for low voltage installations. By increasing the voltage level of the on-board distribution system, the energy conversion can achieve higher efficiencies and be more compact, due to the smaller cross-sectional area of conductors and lower losses. However, for waterborne transport (waterborne transport refers to both maritime and inland waterway transport) applications, challenges remain related to the design of conversion systems and insulation methods for integrating low voltage battery systems in high voltage AC or DC distribution systems. The necessary regulatory aspects also need to be defined to facilitate market take up for waterborne transport. Although e.g. high-voltage Li-Ion battery packs may be presently applied, the current state-of-the-art still offers solutions that are too heavy to enable electrification of a wider range of larger waterborne transport assets. However new developments show potential for a reduction of battery pack weight. Further study of the adaptation and the on-board integration solutions available for recently developed technologies, such as Li-Ion NMC, LTO, LFP is needed.

Building on the current state of the art solutions should contribute towards the battery electrification of a wider range of vessel types, for both maritime and inland waterway transport which are characterized by the need for larger battery systems and longer autonomy.

Projects are expected to address all of the following aspects:

- Design of battery management systems of high voltage battery installations for AC and DC distribution systems in waterborne transport.

- Design and control of conversion systems, insulation design and insulation coordination.
- Adoption of low weight electrical energy storage designed to be integrated on board (e.g. not an on deck ISO container).
- Sustainability and circularity criteria to be preferably adapted for whole life of on-board battery pack solutions (i.e. second-life applications).
- Identification and characterisation of the specific requirements needed for inland waterway and maritime transport.
- Development of battery safety concept that is in principle suitable for class approval, especially for large battery spaces on-board, considering detection, ventilation and fire suppression technology.
- Identify and, if necessary, support the development of any new standards and certification procedures which will be required to facilitate deployment of the developed new technologies and solutions.

The new solutions should also contribute significantly to the overall safety for on-board battery applications (i.e. for toxic emissions, fire propagation, etc.). The form factor, the battery management system and the interface with the shore side electric grid should also be considered.

The projects are expected to ensure synergies with the Horizon Europe Batteries Partnership and are encouraged to envisage clustering activities with the project funded from the topics HORIZON-CL5-2021-D2-01-02 and HORIZON-CL5-2021-D2-01-03.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-12: Combining state-of-the-art emission reduction and efficiency improvement technologies in ship design and retrofitting for contributing to the "Fit for 55" package objective by 2030 (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions

<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Development of at least three market ready vessel design solutions to address short sea shipping, inland waterway transport and high seas shipping making innovative use of combinations of close to market (TRL 7 or higher) emission reduction and efficiency improvement technologies to reduce emissions from shipping in line with the expectations within the EUs “Fit for 55” legislative package.
- Quantitative assessment of the designs towards achieving significant emissions reductions consistent with the EU’s ‘Fit for 55’ package objectives and the IMO’s Carbon Intensity Indicator through verifiable KPI’s.
- Facilitation of the continuous improvement and upgrading of existing vessels to increase efficiency and reduce emissions through the measurement and bench marking of operational profiles.
- Quantification of the contribution towards cutting emissions from a range of emission reduction technologies on a life cycle basis. Including the separate and joint consideration of design and operations within relevant environments. Enable assessment of the retrofit and refurbishment options of applied emission reduction technologies.
- Support accelerated conversion of inland and maritime vessels towards better energy efficiency and reduced emissions.
- Development of robust business models for the design concepts, to ensure a high probability of commercial European deployment and the expectation of becoming operational by 2030.

Scope: Legislative proposals within the EU's "Fit for 55" package targeting the reduction of waterborne transport emissions will assess emissions reductions based on operational data collected within the framework of the EU's MRV regulation. Internationally, for global maritime shipping, the forthcoming IMO Carbon Intensity Indicator and Data Collections System (DCS) will be used. Vessels visiting EU ports will need to provide data to ensure compliance with both MRV (EU) and DCS (IMO) data requirements. This change from assessing emission reductions based on design to the direct measurement and verification of actual operational emissions requires a new approach to design. Consequently, the vessel design process will need to employ modelling and simulation techniques which take into account the vessel's expected operational profile and life cycle so as to ensure that the delivered vessel or modification will deliver the expected emission reductions in the "real world"

For new builds, present improvements in ship energy efficiency have reduced consumption by 15-30% compared to equivalent reference ships in 2008. Contributing to fit for 55 objectives, the challenge is to develop at least three concept vessels which will further improve energy efficiency by at least 20%, compared to a 2022 reference performance for equivalent ships.

This "design for operation" approach will integrate and combine both operational energy savings and emission reduction technologies. Several technologies and solutions to be combined and integrated should be chosen so as to provide the largest impact and these are expected to already be individually demonstrated or developed to TRL 7. This could for example concern various combinations of; power conversion/electrification /energy devices, sustainable climate neutral low emission fuels, HVAC, energy storage, operations, smart energy monitoring, renewables including wind assistance, hydrodynamics, cold ironing, slow steaming, just in time scheduling, propeller designs etc.

In order to address the above-mentioned challenge, proposals are expected to address all the following aspects:

- Energy system modelling and fast simulation assessment to demonstrate the expected energy efficiency gains and life-cycle emission reductions achieved by the resulting designs within their operating reference cases. A holistic/systemic approach should be applied to the design, which is to be based upon total vessel energy needs for use within reference operating profiles and business cases.
- A minimum of three vessel concept designs and use cases are expected to be developed including the following vessel types: short-sea, inland waterway and high-seas. For each vessel type, retrofit solutions for the baseline design (from 2008) should be proposed, as well as a completely new design.
- Development of an open-source design assessment tool which can be used to assess the operational Carbon Intensity of vessel designs.
- Development of decision-support or automation systems to facilitate the most effective implementation of operational energy efficiency improvements.

- Plans for exploitation and dissemination of results should include a strong business case and sound exploitation strategy. Development of business models to facilitate the deployment of the resulting vessel design concepts, in particular addressing financing, market needs and possibilities to support first of a kind deployment. Considering the potential of opportunities within EU support schemes such as the Connecting Europe Facility, Climate Change Innovation Fund and regional funds. Proposals are expected to demonstrate a clear and credible pipeline from the development to the operational deployment of the developed designs by 2030. This should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

When appropriate, activities may also address the definition of a secure knowledge sharing platform to enable the necessary data-transfer to obtain detailed operational performance information.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-13: Demonstration of Technologies to minimise underwater noise generated by waterborne transport (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Demonstration of underwater radiated noise (URN) reduction through large scale demonstrators or retrofitted ships employing URN reduction modifications and assessment through verifiable KPIs.
- Demonstration of the effectiveness, safety and cost-effectiveness of noise mitigation devices, mitigation measures and management options and assessment through verifiable KPIs.
- Development of standards for the specification of source noise levels by equipment suppliers and shipyards, which build upon the current state-of-the art.
- Has increased the awareness of European ship owners of the environmental impact from underwater noise and the possibilities to reduce noise and its harm to the marine environment.
- Provide evidence to regulators concerning waterborne transport underwater noise to better take into account operational conditions and environmental impact within any forthcoming regulation.

Scope: Whilst on-going research seeks to characterize the underwater radiated noise (URN) which poses the greatest threat to aquatic species and the marine environment as well as characterizing potentially promising solutions to reduce the impacts of URN, the demonstration of technologies to minimize the harmful impacts from waterborne transport URN remains less developed. Current on-site URN measurement campaigns do not address all potential waterborne transport related noise sources and selecting suitable mitigation measures remains a challenging task as there are many options for URN reduction. Consequently, assessments need to be made on a case-by-case basis considering environmental, operational and economic factors and when relevant taking into account previous work such as the European Marine Board position paper on underwater noise. An important challenge is to predict URN at the design stage to be able to implement less noisy environmentally friendly solutions from an early stage. This challenge is faced both at equipment design level and at the ship integration stage. Consequences of the noise reduction solutions for GHG emissions should be considered.

Current approaches to the regulation of URN focus on controlled criteria (fixed speed, no waves etc.), whilst ships operate at various speeds, loads and sea states which further complicate the challenge of designing a quiet ship suitable for a wide range of conditions. A further challenge is to be able to operate a noise measurement system on-board which can provide instantaneous information to the crew on the ship's operational radiated noise. Noting that an informed balance may also need to be taken between GHG emissions and URN.

In order to address the above-mentioned challenge, proposals are expected to address all the following aspects:

- Development of methods and models to predict under water radiated noise levels in the design phase.

- Conduct modelling and field studies to improve the effectiveness, safety and cost-effectiveness of noise mitigation devices, mitigation measures and management options in different sea states and in different ship loads. The identified solutions should be tested and demonstrated through large scale demonstrators that may, when appropriate, and feasible, also include the monitoring of the response of key susceptible species.
- Projects should develop systems for on-board measurement of noise, and decision support systems to reduce radiated noise whilst maintaining energy efficiency in normal operation.
- The project should build upon the current state of play, for example taking into account the H2020 project SATURN and the LIFE+ project PIAQUO to support the development of standards for the specification of source noise levels by equipment suppliers and shipyards. The projects are expected to propose synergies and clustering with related projects and activities addressing underwater noise, including from non-transport sources.
- In addition, the project should address communication towards the European ship owners and operators to raise awareness, inform about the environmental impact and on the technical possibilities to reduce their noise and its impact on the underwater environment.
- Engage with regulators to raise awareness on noise from waterborne transport depending on operational status, weather conditions, loading conditions, water conditions (depth, type of bottom, temperature salinity etc.) the frequency and type of noise and its impact on the environment for the purpose of considering them in future potential regulations.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-14: Demonstrating efficient fully DC electric grids within waterborne transport for large ship applications (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following

	<p>exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible costs.</p>

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Enabling reduced emissions from waterborne transport through increased electrification including hybrid power systems.
- Demonstration of the feasibility of a secondary smart DC grid (engineering framework, distribution/protection devices).
- Demonstration of smart management and control of hybrid electric plants, combining different energy sources, including sustainable climate neutral fuels so as to minimize total lifecycle net GHG emissions
- Development of a new configuration for the entire power generation architecture for large scale waterborne transport ready to be deployed.
- Development of new power electronic systems for AC/DC converters and DC circuit breakers within the electrical network with higher efficiency.
- Assessment of the waterborne transport emission reduction from increased electrification including hybrid power systems. Benchmarking and quantification of achieved GHG emission reduction through relevant quantifiable KPIs.
- Assessment through verifiable KPIs of the operating costs reductions and the reduction in emissions by cutting energy consumption and extending service intervals of the generator sets.
- Assessment through verifiable KPIs of the efficiency and power density improvements to reduce the overall volume and weight.

Scope: Primary DC systems are now applied on multiple types of ships, employing battery energy storage. The application of DC grids on-board has already started and will grow

significantly because of its promising aspects such as reduction of complexity, increased modularity and improved integration. However, further progress is required to unlock the full potential of an on-board DC grid for large ship applications (over 5000 GT) addressing the entire network for both primary and secondary (auxiliary) distribution system, taking into account the various on-board applications of ship's electrification systems (e.g. high-power fuel cells, batteries, etc.) The challenge is to focus not only on secondary distribution, but also on the integration/interconnection of new sustainable primary power systems within a DC grid network serving the entire ship

In order to address the above-mentioned challenge, proposals are expected to address all the following aspects:

- Develop high TRL innovative power electronic systems (e.g. converters, circuit breakers with logic selectivity) adapted and certified for waterborne transport applications.
- Develop a new concept of smart, flexible, plug-and-play DC power grid which leverages the capability of new power electronic systems and allows for different DC power generation systems based on sustainable alternative energy sources.
- Research the impact of design choices, safety measures and integration on the ship. This will require the development and on-board integration of high-power equipment and systems to complement the electrical grid (e.g. solid-state protection, solid-state transformers, Silicon-Carbide Power Devices,
- Develop a prototype system at small scale (min. 100kW) within a real waterborne transport environment. Demonstrate the functionality and the integration of its components, prove the possibilities for further upscaling. Prove the feasibility and benefits of distributing main power based on DC instead of AC.
- Validate the system with classification societies ensuring the highest standards for safety and reliability.
- Develop standards for on-board DC microgrids and communication protocols which are particularly valuable for large ships where there is differentiation between the electrical supplies towards different zones (e.g. zones with ICE and zones with RES systems).
- Integrate new power electronic systems within the ship's network with advanced control systems to cope with variable loads and high levels of DC currents to interrupt.
- The emissions, efficiency and operational savings are expected to be demonstrated on a relevant ship type to validate the research results. The transferability of the applications to be applied has to be proven towards a range of vessel types, including those which have larger battery systems and longer autonomy. The demonstration is expected to serve as a reference for a wide spectrum of ship's types using electrical propulsion and auxiliary power.

- Where relevant, synergies and collaboration should be planned with the related activities and projects arising from linked Horizon Europe initiatives, in particular the Batteries and Clean Hydrogen JU partnerships.
- Plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

All relevant stakeholders (electrical distribution and protection manufacturers, engineering companies, manufacturers of electrical equipment, users, shipyards, etc.) should participate in proposals in view of the systems development.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-15: Advanced digitalisation and modelling utilizing operational and other data to support zero emission waterborne transport (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.70 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 7.70 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Development and demonstration of a platform for Integrated Green Vessel Digital Twins that will provide a basis to continuously improve the environmental performance of vessels over their entire life cycle.
- Improved environmental performance through verifiable KPIs.
- Proven applicability of the platform to a wide variety of vessel operations throughout the vessels' lifetime, by using model-based systems engineering, simulation and hardware in the loop approaches.

Scope: State-of-the-art of Digital Twins (DT) applied to waterborne transport are typically characterised by a focus on specific limited aspects of the design or operation of a vessel based on numerical simulations. Integrated Green Vessel DTs, which take an integrated approach to combine design and operation to improve efficiency and reduce emissions are not well addressed. Furthermore, aspects of open (software) architecture, data standards, security guarantees and data sovereignty of data owners are also not comprehensively addressed. Whilst some advances in data integration for different applications have been made, a comprehensive global integration of data remains missing.

These higher levels of integration between different functions of an Integrated Green Vessel DT (e.g. during design and operation of waterborne transport assets) require both complex multi-physics simulations and advanced levels of data organisation. This leads to the need for higher computational efficiency to meet future requirements in terms of accuracy, and the integration of the digital representation of suitable technologies for the transformation of vessels into “Green Vessels” within an Integrated Green DT that will aim to improve the vessels environmental performance.

Integrated Green Vessel DTs need to be applicable throughout the life cycle of the vessel, from initial design, to detailed design, engineering and production, operation, retrofitting, and circular end of life. To make best use of an Integrated Green Vessel DT, it should allow addressing optimisation for enhanced energy efficiency and reduced environmental footprint in a consistent way throughout the lifecycle of the vessel. This will require a thorough consideration of potential operational conditions as well as possible future regulatory changes. The Green Vessel DT will play a key role in design and operation of future zero or low emission vessels as well as their through-life sustainability upgrades. Mapping all relevant data influencing operational environmental performance, it will be the basis for decision support for operational (AI-based) optimisation, for considering the use of for example propulsion changes, retrofits, alternative fuel options, use of renewable energies solutions) and predictive maintenance.

Proposals are expected to address all of the following aspects:

- Development of an Integrated Green Digital Twin.
- Make best use of available (simulation) concepts and consider all relevant life-cycle aspects, including end of life disposal.

- Incorporate all relevant aspects of physics simulation, design and operational planning and optimisation as well as data organisation and storage, integrating also real data obtained from monitoring and measurements.
- Ensure the system will be adaptable to consider all potentially relevant retrofits needed to meet future regulations and changes in operational profile both during initial design and throughout the vessels lifecycle.
- Assessment of the environmental performance through verifiable KPIs.
- Optimisation of the vessel’s equipment in operational conditions in order to provide the best environmental and economic solution for a given waterborne transport operation.
- Use open standards, libraries and tools to create generic and reusable solutions applicable to a wide range of waterborne assets.
- Ensure the interoperability of data models, address data ownership and integrity of data sets as well as ensuring security against cyber and physical threats.
- For case studies on at least 2 different ship types, test and demonstrate the developed digital twin model to quantify the improved environmental performance and efficiency achieved as a result.

Plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-16: Structuring the Waterborne transport sector, including through changed business and industrial models in order to achieve commercial zero-emission waterborne transport (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 0.85 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 0.85 million.

<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).²⁸⁸.</p>

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- A full understanding of the business model, labour, financial and commercial barriers to the take up of innovative low and/or zero emission solutions for waterborne transport, including consideration of ship financing and investment structures, charter and other contracts.
- Identification of potential solutions to overcome business model and commercial barriers to the take up of innovative low and zero emission solutions in waterborne transport.
- Understanding of the industrial capacity and how it would be scheduled to retrofit and/or replace the current European fleet to meet 2030 and 2050 emission reduction and pollution targets. Considering all vessels operating within the European region, including inland waterway transport vessels, short sea shipping services (including ferries and cargo vessels), cruise and offshore vessels;
- Increase commitment from the wider waterborne sector, including finance, contracting insurance, charterers, operators, owners, public stake holders, technology providers as well as civil society towards recognizing the importance of European waterborne transport, its environmental objectives and the consequential economic impacts.

Scope: The European Green Deal sets ambitious objectives to transform Europe into the first climate neutral continent by 2050 This presents a valuable opportunity for the European

²⁸⁸ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

industry, and in particular for the waterborne transport sector, where Europe leads in high technology and green energy efficient shipping development. Also digitalisation has an impact on reducing emissions and increasing efficiency, while increasing safety, security, and reliability of the waterborne transport, and therefore is already impacting the business models and dynamics of the sector.

Whilst Europe is still a worldwide leader in advanced, digital and green shipping, there is a lack of take up of new technologies within the wider waterborne transport market. In part, this is a reflection of the sectors' conservatism and reluctance to change unless driven by regulation. It is also hindered by the complex commercial structures and finance models which can distance the interests of ship owners who commission new builds, financiers who commoditise vessel value by type, operators who can benefit from lower fuel consumption as well as cargo owners who may benefit from 'environmentally friendly image' and final points of sale where the use of low emission shipping can be a potential commercial advantage. Whilst new business models and labelling schemes to better incentivize green shipping have been developed, they are yet to be widely established and are largely unknown. There is a need to objectively analyse the segments of the waterborne transport sector, and within each segment characterize the business models, identify the barriers to the take up innovative low and zero-emission waterborne transport solutions and in cooperation with the stakeholders to propose commercial models which can provide a better incentive for increasing the investment in low or zero-emission solutions in the European waterborne transport sector.

Furthermore, it is important to increase awareness of the public and the broader non research waterborne sector about the economic and environmental importance of the European waterborne transport sector, highlighting its commitment, ability and opportunities to develop and implement competitive solutions which will meet the ambitious objectives reflected in the European Green Deal.

To ensure a coordinated approach to develop zero-emission, digital, automated and competitive European waterborne transport the participation of all types of both private and public stakeholders, including financiers, charterers and others within the commercial side of the waterborne business community should be envisaged. Cooperation with relevant existing initiatives, like the European Sustainable Shipping Forum, CESNI, the Waterborne Technology Platform and others, will be key. In addition, it should be ensured that proposals take into account the results of relevant R&I projects (including Horizon 2020 and Horizon Europe) and relevant studies. Proposals should address all of the following:

- Identify business models and the financial and commercial barriers to the take up of innovative low and/or zero emission solutions for waterborne transport. The financial investment, labelling and contract structures as well as the new possibilities enabled by digitalisation should be considered. An analysis of the different responsibilities and business motivations between charterer, cargo owner, ship owner, point of sale etc. should also be taken into account.

- Analyse the needs and timing to retrofit and replace the current European fleet (including inland waterway transport vessels, ferries, short sea shipping, cruise ships and offshore vessels). The analysis should be combined with an overview of the European capacity (with respect to technology and skilled workforce) available to retrofit these vessels and identify any capacity gaps for the timely implementation of the European Green Deal emission targets;
- Provide an analysis of where disincentives exist to the increased deployment of innovative low and/or zero emission and smart shipping, within different market segments/ The analysis should consider for example the investment decision cycle: finance models, bunkering and fuel supply infrastructure, availability, longevity and costs of technologies, possibilities to retrofit/build a vessel timely, properly skilled workforce, etc. and propose incentives and improvements to the business models such as new contract models and financing structures.;
- Organise specific communication and exploitation activities towards relevant stakeholders outside the participants of the project to ensure that all stakeholders from EU Member States/Associated countries are informed about the solutions developed;
- To assure a beneficial societal impact from the activities, relevant social science and humanities expertise are expected to be taken into account, including the active contribution from SSH experts and/or institutions.

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D5-01-17: Coordinating and supporting the combined activities of member and associated states towards the objectives of the Zero Emission Waterborne Transport partnership so as to increase synergies and impact (ZEWT Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 1.50 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply:

	<p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p> <p>In order to ensure appropriate impact, proposals must include National Authorities or national R&I funding bodies from at least 5 EU Member States or Associated Countries.</p>
<p><i>Legal and financial set-up of the Grant Agreements</i></p>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).²⁸⁹.</p>

Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Increase the impacts arising from the Zero Emission Waterborne Transport (ZEWT) European partnership towards the achievement of zero emission waterborne transport in Europe.
- Leverage the efficiency of national and EU R&I investment to accelerate the development and deployment of zero emission waterborne transport for both European and national benefit.
- Further align national programs with the activities and outcomes of the ZEWT co-programmed European Partnership;
- Establish a cooperation mechanism between EU Member States and Associated countries to jointly fund research related to the objectives of the ZEWT co-programmed European Partnership;
- Creating a critical mass and excellence in precompetitive breakthroughs related to the objectives of the ZEWT co-programmed European Partnership.
- Reinforced synergies between ZEWT actions within Horizon Europe and those of EU Member States and Associated countries within other EU programs such as the Blue Economy Partnership, European Regional Development Fund, Connecting Europe Facility, Innovation Fund and other national programmes.

²⁸⁹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Scope: EU Member States and Associated Countries have previously cooperated in the framework of the Horizon 2020 ERA-NET Co-fund MarTERA (“Maritime and Marine Technologies for a New ERA”) which engaged 16 countries which together launched joint calls that supported nearly 50 joint projects with €56M of funding. This has established valuable coordination between national and European research, including with the waterborne transport sector. The benefits from synergies towards the achievement of common goals which align with the objectives of the ZEWT partnership. This requires better coordination and harmonisation of individual national funding programmes as well as consideration and alignment with the ZEWT partnership and its related calls and projects. Furthermore, national administrations are best placed to facilitate this alignment and the increased participation of SMEs within European projects which are aligned with the objectives of ZEWT. Amongst a critical mass comprising national authorities and R&I funding bodies from multiple EU Member States/Associated countries will contribute to increasing the impact from the activities of the partnership and its related calls and projects as well as accelerating implementation of the partnerships SRIA and enhancing the efficiency, synergies and impacts of national activities which are aligned with ZEWT objectives, also engaging with relevant networks of Horizon Europe National Contact Points.

With respect to actions which are aligned with the objectives of the ZEWT partnership, activities should include all of the aspects below:

- Facilitating collaboration between member and associated states in a variety of configurations including possibly joint calls to increase synergies, impact and efficiency of national activities as well as accelerating progress towards achieving the objectives of the ZEWT partnership. However, activities will not include support to the projects themselves and their management.
- Reinforcing the complementarity of national schemes towards the take up and deployment of European R&I results which are aligned with the objectives of ZEWT and thereby increasing impact and value from European and national investments.
- Reinforcing synergies between ZEWT related actions addressed within Horizon Europe and those of EU Member States and Associated States within other EU programs such as the Blue Economy Partnership, European Regional Development Fund, Connecting Europe Facility, Innovation Fund and other national programs

This topic implements the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Zero Emission Waterborne Transport’ (ZEWT) in support of the monitoring of its KPIs.

Transport-related health and environment

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D5-01-18: Assessment of air pollutant emissions from low-carbon fuels in the heavy-duty, aviation, and maritime sectors

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 7.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: To support the [Zero Pollution Action Plan](#)²⁹⁰, project results are expected to contribute to all of the following expected outcomes:

- The air pollutant emissions from combustion-based heavy-duty vehicles (including Non-Road Mobile Machinery like excavators, bulldozers, harvesters etc.), aircraft and ships using alternative fuels, with a broad coverage of existing (at least in advanced prototype form) powertrains and exhaust after treatment technologies, are measured and characterised according to real-life scenarios of use.
- Emerging pollutants resulting from the use of novel low-carbon fuels are identified and quantified.
- In light of recent WHO guidelines, concentrations of ultrafine particle emissions down to at least 10nm are also measured and chemical compounds present on those particles are characterised (in particular carcinogenic compounds like aldehydes, PAHs and NPAHs).
- Air pollution exposure projections based on plausible technological trajectories are produced, up to the year 2050.
- Technology packages to mitigate the emerging forms of pollution are proposed and projections updated accordingly.

²⁹⁰ https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_

- Reliable scientific data to guide future policy and technology choices following the “do no significant harm” principle is provided.
- Guiding principles for optimized Design, Operation and Maintenance, to minimize emissions, for designers and operators.

Scope: Low- or zero-carbon fuels proposed for use in the next decade can be covered, however the priority is on fuels that have already been demonstrated in real world applications or are foreseen to gain market share according to the projections made in the context of the ‘Fit for 55’ package.

A complete polluting emissions speciation should be performed in different working conditions encountered in real use. Therefore, the pollutants expected to be quantified should go beyond the list of the currently regulated ones.

Since accessing ships and aircrafts for testing is not straightforward, and no fuel or engine development work should be funded in the proposals, cooperation with existing projects where such fuels are tested is expected.

A study of possible mitigation actions should focus on any new pollutants that have a high toxicity, a high global warming potential, or both.

The potential from upstream emissions and of secondary pollutants formation in the atmosphere deriving from the new emissions should also be considered and quantified. Any trade-offs between GHG effects over the next 20-year period, health and other environmental impacts should be identified and assessed.

The projects should assess impacts on human health, in particular those of any emerging pollutants.

In consideration of the above, proposals should address all the aforementioned aspects and issues in order to achieve the expected outcomes

Destination – Safe, Resilient Transport and Smart Mobility services for passengers and goods

This Destination includes activities addressing safe and smart mobility services for passengers and goods.

Europe needs to manage the transformation of supply-based transport into safe, resilient and sustainable transport and demand-driven, smart mobility services for passengers and goods. Suitable research and innovation will enable significant safety, environmental, economic and social benefits by reducing accidents caused by human error, decreasing traffic congestion, reducing energy consumption and emissions of vehicles, increasing efficiency and productivity of freight transport operations. To succeed in this transformation, Europe's ageing (and not always sustainable) transport infrastructure needs to be prepared for enabling cleaner and smarter operations.

Europe needs also to maintain a high-level of transport safety for its citizens. Resilience should be built in the transport systems to prevent, mitigate and recover from disruptions. Research and innovation will underpin the three safety pillars: technologies, regulations and human factors.

This Destination contributes to the following Strategic Plan's **Key Strategic Orientations (KSO)**:

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy²⁹¹ by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations.*

It covers the following **impact areas**:

- Industrial leadership in key and emerging technologies that work for people;
- Smart and sustainable transport.

The **expected impact**, in line with the Strategic Plan, is to contribute to “*Safe, seamless, smart, inclusive, resilient and sustainable mobility systems for people and goods thanks to user-centric technologies and services including digital technologies and advanced satellite navigation services*”, notably through:

²⁹¹ ‘Open strategic autonomy’ refers to the term ‘strategic autonomy while preserving an open economy’, as reflected in the conclusions of the European Council 1 – 2 October 2020.

- Accelerating the implementation of innovative **connected, cooperative and automated mobility (CCAM)** technologies and systems for passengers and goods (more detailed information below).
- Further developing a **multimodal transport system** through sustainable and smart long-haul and urban freight transport and **logistics**, upgraded and resilient physical and digital **infrastructures** for smarter vehicles and operations, for optimised system-wide network efficiency (more detailed information below).
- Drastically decreasing the number of **transport accidents, incidents and fatalities** towards the EU's long-term goal of moving close to zero fatalities and serious injuries by 2050 even in road transportation (Vision Zero) and increase the **resilience** of transport systems (more detailed information below).

Connected, Cooperative and Automated Mobility (CCAM)

Joint actions are foreseen between the “Cooperative Connected and Automated Mobility” (CCAM) partnership, the “2ZERO” Partnership and the Mission on “Climate Neutral and Smart Cities”, in particular the Joint topic “Co-designed smart systems and services for user-centred shared zero-emission mobility of people and goods in urban areas (see work programme of the Cities’ Mission 2023).

To test CCAM solutions, applicants can seek possibilities of involving the European Commission’s Joint Research Centre (JRC) in order to valorise the relevant expertise and physical facilities of JRC in demonstrating and testing energy and mobility applications of the JRC Living Lab for Future Urban Ecosystems <https://ec.europa.eu/jrc/en/research-facility/living-labs-at-the-jrc>

Main expected impacts:

- Seamless, affordable and user oriented CCAM based solutions with particular focus on shared, smart and zero emission mobility and goods deliveries for all and high public buy-in of these solutions.
- Validated safety and security, improved robustness and resilience of CCAM technologies and systems.
- Vehicle technologies and solutions which optimise the on-board and off-board experience in terms of well-being, security and privacy.
- Comprehensive set of verification, validation and rating procedures of CCAM systems
- Secure and trustworthy interaction between road users, CCAM and “conventional” vehicles, physical and digital infrastructure and services to achieve safer and more efficient transport flows (people and goods) and better use of infrastructure capacity.

- Clear understanding of societal needs and impacts of CCAM (including ethics, employment, socio-economic impacts) at individual and collective level, to ensure a more tailored, resilient and sustainable deployment of CCAM solutions.
- Better coordination of public and private R&I actions, large-scale testing and implementation plans in Europe towards harmonisation and standardisation.

Multimodal and sustainable transport systems for passengers and goods

Main expected impacts:

- Upgraded and resilient physical and digital infrastructures for clean, accessible and affordable multimodal mobility.
- Sustainable and smart long-haul and regional (including links to urban) freight transport and logistics, through increased efficiency and improved interconnectivity.
- Reduced external costs (e.g. congestion, traffic jams, emissions, air and noise pollution, road collisions) of passenger mobility and freight transport, as well as optimised system-wide network efficiency and resilience.
- Enhanced local and/or regional capacity for governance and innovation in passenger mobility and freight transport.

Safety and resilience - per mode and across all transport modes

Main expected impacts:

Safety in Urban Areas / Road Transport Safety

- Drastic reduction in serious injuries and fatalities in road crashes by 2030 and establishing a framework to improve traffic safety culture in the EU.
- Avoiding risks, collisions and finding new ways of reducing long term consequences of road crashes.
- Minimising the effects of disruptive changes on transport safety and improving the resilience of transport systems by design.
- Better infrastructure safety on urban and secondary rural roads throughout a combination of adaptable monitoring and maintenance solutions.

Waterborne Safety and Resilience

- *Ensure safe and secure exploitation of technologies like digitalisation, Internet of Things, and sensors*

Aviation Safety and Resilience

*Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility*

- Ensure safety through aviation transformation (from green/digital technologies uptake up to independent certification).

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL5-2023-D6-01	108.50		05 Sep 2023
HORIZON-CL5-2024-D6-01		122.50	05 Sep 2024
Overall indicative budget	108.50	122.50	

Call - Safe, Resilient Transport and Smart Mobility services for passengers and goods

HORIZON-CL5-2023-D6-01

Conditions for the Call

Indicative budget(s)²⁹²

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²⁹³	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D6-01-01	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D6-01-02	RIA	20.00	Around 20.00	1
HORIZON-CL5-2023-D6-01-03	IA	12.00	Around 6.00	2
HORIZON-CL5-2023-D6-01-04	RIA	8.00	3.00 to 4.00	2
HORIZON-CL5-2023-D6-01-05	RIA	2.00	Around 2.00	1
HORIZON-CL5-2023-D6-01-06	RIA	6.00	Around 3.00	2
HORIZON-CL5-2023-D6-01-07	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D6-01-08	CSA	3.00	Around 3.00	1
HORIZON-CL5-2023-D6-01-09	IA	14.00	Around 7.00	2
HORIZON-CL5-2023-D6-01-10	RIA	10.00	Around 5.00	2
HORIZON-CL5-2023-D6-01-11	RIA	8.00	Around 4.00	2

²⁹² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.

The Director-General responsible may delay the deadline(s) by up to two months.

All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

²⁹³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

*Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility*

HORIZON-CL5-2023-D6-01-12	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D6-01-13	CSA	1.50	Around 1.50	1
Overall indicative budget		108.50		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Connected, Cooperative and Automated Mobility (CCAM)

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D6-01-01: User-centric development of vehicle technologies and solutions to optimise the on-board experience and ensure inclusiveness (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions

<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Advanced vehicle technologies and solutions which optimise usability, perception and experience on-board, and when boarding/off-boarding, in terms of security, privacy, well-being, health and assistance.
2. Enhanced inclusiveness and trust in the interaction between users and new automated modes of road transport and mobility services in the transition from human-driven to automated vehicles.
3. Safety and security of vehicle occupants in all circumstances even when the vehicle is driverless by helping to prevent dangerous and inconvenient situations, also when boarding/off-boarding.
4. Strengthened cooperation between users, vehicle manufacturers, suppliers, researchers and other stakeholders to co-design vehicles with solutions that optimise the on-board experience.
5. Better understanding of the benefits of new vehicle technologies and solutions in terms of on-board experience, inclusiveness and trust to enable wider user acceptability and hence contribute to the creation of future standards.
6. Full exploitation of the new opportunities offered by automated vehicles to provide user-centric, accessible and inclusive mobility for all.

Scope: In the transition from human-driven to automated vehicles, optimising the on-board experience and overall satisfaction of users is paramount for high social buy-in and widespread adoption of CCAM-based mobility solutions. This can be achieved through the development, integration and validation of advanced vehicle technologies and solutions that serve to optimise the usability, perception and experience on-board and when boarding/off-boarding. Such solutions should be designed holistically by adopting a universal design approach from an inclusive, user-centric perspective. All users will demand vehicles that allow and facilitate relaxing, social or work-related activities within a space designed for health and well-being and that are responsive to individual needs (depending on gender, age, disability, size, weight etc.), while ensuring privacy for social interaction. Hence, a wide range of different user groups are expected to be involved early in the development phase to

have their specific needs understood, in order to develop technologies and solutions for individual and shared automated vehicles that meet the demands of all.

To achieve these objectives, it is expected that activities will focus on the development and validation of a range of new, advanced technologies and solutions that leverage the latest advances in technologies and know-how in terms of ensuring a seamless interaction between the vehicle and its occupants that are also fully aligned with safety requirements (and future standards), including at least the following aspects:

- Perception-focused solutions and features (e.g. temperature, lighting, sound/acoustics, vibration, seating, posture), aimed at enhancing the sense of safety, privacy, and well-being while eliminating stress, including personalisation, addressing the specific needs of individuals from diverse user groups (e.g. elderly, disabled, tourists).
- Alternative, flexible and automated interior configurations to better suit occupants' needs.
- Solutions that further advance the state-of-the-art with respect to tackling motion sickness.
- Adaptive systems that can also transfer preferred personal settings between vehicles to increase the user acceptability of shared vehicles.
- New mobility services also for users with special needs (e.g. elderly and disabled), which take into account the heterogeneous requirements and preferences of different target groups.
- Technologies to ensure the security of the occupants, which monitor inside and outside the vehicle to reduce the risk of its misuse and counteracting dangerous situations (e.g. assaults, vandalism, thefts, etc.).

It will be necessary, also based on feedback from user groups, to assess how the technologies and services developed benefit on-board experience and inclusiveness.

This topic requires the effective contribution of SSH disciplines including ethics and gender and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on 'Connected, Cooperative and Automated Mobility' (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership 'Connected, Cooperative and Automated Mobility' (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D6-01-02: Generation of scenarios for development, training, virtual testing and validation of CCAM systems (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

1. Improved validation of CCAM systems enabled by real and synthetic test scenarios, with the widest possible coverage of traffic situations CCAM systems can encounter on European roads.
2. Efficient provision of relevant test scenarios in a permanently updated and therefore dynamic EU wide database.
3. Accelerated AI development and training making use of the dynamic scenario database.
4. Use of the most appropriate approaches (e.g. vehicle-based versus (quasi-)stationary sensor units) to record relevant traffic data, as a basis for the derivation of test scenarios, in different traffic environments according to extending ODDs.
5. Commitment from key stakeholders to the validation methodology, the scenario database and its usage and to the provision of significant volumes of raw data and/or scenarios extracted from such data.

Scope: Higher levels of CCAM require validation methodologies making use of scenario-based physical and virtual testing, thereby complementing real-world test drives on public roads, audits and in-use reporting. Scenario-based testing is necessary as conventional testing and validation approaches would require driving hundreds of millions of test kilometres

before new CCAM systems or system updates can be deployed. The development of common scenario-based validation methodologies is the subject of HORIZON-CL5-2021-D6-01-02²⁹⁴ and should be based on the results of the HEADSTART project²⁹⁵. To enable these common validation methodologies to be widely used, relevant test scenarios need to be provided. These scenarios can partly be defined based on expert knowledge, which, however, needs to be complemented by the extraction of test scenarios from real traffic data²⁹⁶, from collision data and in the future, from advanced traffic simulations. The aim of this call topic is to generate a wide range of test scenarios for the training, testing and validation of CCAM systems with a focus on urban and rural traffic, for which there is significantly less knowledge on relevant scenarios than for motorway driving.

To maximise the outcomes, proposed actions should demonstrate upfront commitment from key stakeholders to the validation methodologies, as developed and used in HEADSTART, in a project to be funded under HORIZON-CL5-2021-D6-01-02²⁹⁷, in L3Pilot and in Hi-Drive, either by providing significant volumes of raw data or by providing scenarios extracted from such data making use of the automated processing chain. Furthermore, stakeholders should dedicate resources to ensure that the scenarios are developed in a manner that maximises their utility also to other entities and their successful integration in their future (virtual) development and testing processes. Proposed actions are expected to share scenarios in an openly accessible EU wide database, which should be established by a project to be funded under HORIZON-CL5-2021-D6-01-02²⁹⁸.

Scenarios and other data shared by stakeholders and existing data made available by national and by other EU-funded projects can be complemented by new data recorded in this action, to provide a realistic set of scenarios with EU-wide coverage.

The proposed actions are expected to address all of the following aspects:

1. AI based tools to transform raw traffic data into reliable, plausibility-proofed data as well as tools for automatic scenario identification and extraction from that data, including the detection of edge cases - the relatively rare, but particularly challenging traffic situations.
2. Generation of variations of scenarios (starting from those based on real traffic data and creating synthetic entries to the scenario database) with a focus on extending ODDs (including adverse weather conditions).
3. Integration of the above in an automatic processing chain with standardised, open interfaces to enable the efficient and seamless use of data from different sources. The processing chain is expected to comply with the FAIR principles, should be agnostic to

²⁹⁴ “Common approaches for the safety validation of CCAM systems”

²⁹⁵ <https://www.headstart-project.eu/>

²⁹⁶ Traffic data in this context refers to microscopic traffic data that describes a driving situation, incl. road layout, road users with their dynamic behaviour, other objects and environmental conditions.

²⁹⁷ Ibid.

²⁹⁸ Ibid.

sensor technologies, data providers and traffic environments, and it should provide for the data management and quality assurance through the whole process.

4. Ensuring reliable merging of scenarios from different data sources (different projects, different vehicles and stationary units, different perspectives etc.).
5. Feeding the resulting scenarios in an openly accessible dynamic scenario database, which can be used for the development, training, virtual testing and type approval validation of CCAM systems, and which should be connected to or integrate existing national databases as far as possible.
6. Quality assurance of the database: Defining approaches and methods to handle uncertainty and the possibility of errors that might propagate in the assessment, including algorithms for their quantification.
7. Demonstration, assessment of the potential and upscaling of (quasi-)stationary sensor units to record high quality big traffic data in various environments, as well as under various environmental conditions and to identify relevant scenarios making use of the processing chain. The focus of recording such data from a “helicopter” perspective - as an alternative to the use of vehicle-based sensors - should be on the provision of suitable data in a cost-efficient way particularly in urban areas. This includes the fusion of data from different sensors. Upscaling requires amongst others the definition of hardware and software requirements for such measuring and recording systems. When recording traffic data in urban areas, proposed action should aim at:
 - o high geographic coverage,
 - o high seasonal coverage including adverse environmental conditions (e.g. extreme weather conditions) and their synchronized recording and
 - o coverage of complex traffic environments including the interaction with other road users (e.g. pedestrians, bicyclists, users of personal mobility devices).
8. Evaluating different approaches to identify relevant scenarios on rural roads based on the developed processing chain and on traffic data to be recorded on various types of rural roads. This includes the fusion of data from different sensors. When recording traffic data on rural roads, roads with low traffic density should be covered in addition to addressing the coverage issues above.
9. Exploring the potential of complementing scenarios extracted from real traffic data with scenarios extracted from validated, highly detailed traffic simulations, including the use of AI to generate edge cases and other adversarial driving conditions in such simulations.
10. Development of a mechanism for the continuous generation of updates of the dynamic scenario database, including an arrangement for the organisational set-up, governance and financial management of the required activities and resources.

The research will require due consideration of cyber security and both personal and non-personal data protection issues, including GDPR. The cyber security of the developed processing chain should be demonstrated for training, virtual testing and validation of CCAM systems.

Proposed actions are expected to develop recommendations for harmonisation and standardisation and to feed into on-going discussions regarding EU type vehicle approval rules as well as in the framework of the UNECE.

In order to achieve the expected outcomes, international cooperation is encouraged in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D6-01-03: Infrastructure-enabled solutions for improving the continuity or extension of Operational Design Domains (ODDs) (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: The funding rate is 60% of the eligible costs, except for non-profit legal entities where the funding rate is up to 100% of the total eligible

	costs.
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Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Infrastructure-enabled solutions improving the continuity of or extending the Operational Design Domains (ODDs).
2. System, data and service architectures for Digital Twins ²⁹⁹ for road transport infrastructure developed and feasibility proven.
3. Input to standardisation, also legal, trust and data security aspects as well as business and governance models (including organisational processes and right of use of data) for Digital Twins.
4. Advanced cooperation of CCAM actors in a robust and functionally safe manner for reasons of ODD continuity/extension, enhancing the readiness of CCAM services and their future extendibility.

Scope: Operational Design Domains (ODDs) of automated vehicle functions are currently limited (e.g. motorways up to 60 km/h). Infrastructure-enabled or -supported solutions can help automated vehicles to overcome the limitation and fragmentation of ODDs. Several Horizon 2020 projects (e.g. INFRAMIX ³⁰⁰, TransAID ³⁰¹, MAVEN ³⁰²) have delivered promising concepts on how infrastructure and vehicles can work together. Projects addressing the first Horizon Europe calls of the CCAM Partnership (most notably HORIZON-CL5-2021-D6-01-03 ³⁰³ and HORIZON-CL5-2022-D6-01-01 ³⁰⁴) are expected to expand on this promising ground ³⁰⁵. Directions for improving the continuity of or extending the ODDs comprise mechanisms such as extended perception and decision-making delegation, supporting the real time knowledge about conditions in the “electronic horizon”, the centimetric accuracy of the positioning signal, the ability of CCAM enabled vehicles to navigate through road works and incident sites.

Digital Twins can improve the real-time availability of information, especially on information that stems from road authorities and road operators. Digital Twins also serve as a data source for prescriptive analytics and simulation environments, in order to improve the efficiency of (virtual) testing and pro-active traffic management. Moreover, Digital Twins play an important role for asset management. The scope includes technology requirements, coherence

²⁹⁹ A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process, in the context here a virtual representation of road transport infrastructure.

³⁰⁰ <https://www.inframix.eu/>

³⁰¹ <https://www.transaid.eu/>

³⁰² <http://www.maven-its.eu/>

³⁰³ [“Physical and Digital Infrastructure \(PDI\), connectivity and cooperation enabling and supporting CCAM”](#)

³⁰⁴ [“European demonstrators for integrated shared automated mobility solutions for people and goods”](#)

³⁰⁵ CCAM Partnership, Strategic Research and Innovation Agenda 2021-2027, December 2021, <https://www.ccam.eu/>, Lessons Learned from completed projects: <https://connectedautomateddriving.eu/projects/lessons-learned/>, Horizon Europe Work Programme 2021-2022, Climate, Energy and Mobility, *European Commission Decision C(2021)4200 of 15 June 2021*.

with proven physical and digital infrastructure support concepts, using Digital Twins for true redundancy and operation in different weather conditions.

As close cross-sectoral collaboration will be necessary, social innovation³⁰⁶ should be considered to support the actions under this topic, thereby empowering different stakeholders and communities in the design, development and implementation of innovative ideas that are in line with societal needs.

Proposed actions for this topic are expected to address all of the following aspects:

- Improve the availability of real-time information beyond the reach of vehicle on-board sensors by developing and demonstrating system, data and service architectures for Digital Twins for road transport infrastructure.
- Remove the discontinuity of the GNSS positioning signal in challenging road environments such as urban canyons and canopies, tunnels, mountainous areas and northern latitudes. Actions should develop approaches to improve the robustness and reliability of the positioning information by local positioning services, landmarks, modules, new procedures and redundancy processes etc.
- Develop novel solutions for the management of and navigation through road works and incident sites for CCAM enabled vehicles, making such high-risk zones much safer for road users (including vulnerable road users), but also for road workers and rescue organisation personnel. Advancing CCAM from information only to services with automated actions requires cooperation in higher classes (“agreement seeking” according to SAE J 3216³⁰⁷). Safe and secure communication, transfer learning, distributed data processing as well as tools and enablers for improving the vehicles’ capabilities of coping with infrastructure imperfections (such as sub-standard infrastructure maintenance) are expected to be addressed. Furthermore, harmonised local traffic management measures at road works and incident sites to support their safe navigation should also be addressed.

Proposed actions should advance the infrastructure-enabled solutions for ODD continuity and/or extension to TRL 6/7 on the way towards (pre-)deployment as an important contribution to large-scale demonstration actions³⁰⁸. EU-wide/global harmonisation is key in this action, enabling broad uptake of services in the common single market and paving the way towards coordinated deployment of necessary infrastructure support for CCAM. Potential needs for standardisation or input for future regulatory action should be identified. Proposed actions should build on NAP (National Access Points) and a Common European Mobility Dataspace to ensure alignment with existing framework.

³⁰⁶ Social innovation concerns the development of new products, methods, and services for and with society to meet societal needs involving citizens, public authorities, business and industry, social partners and academia—the “Quadruple Helix”—in their design, development, and implementation to drive social change and market uptake.

³⁰⁷ https://www.sae.org/standards/content/j3216_202107

³⁰⁸ Published impact evaluation methodologies such as the EU-CEM should be used to evaluate the impact of the solutions as appropriate.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2023-D6-01-04: Integrating European diversity in the design, development and implementation of CCAM solutions to support mobility equity (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 3.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Projects results are expected to contribute to all of the following outcomes:

1. Increased knowledge about the influence of geographical and cultural dimensions on the societal acceptability, uptake and use of CCAM.
2. Integration of geographical and cultural factors in the planning, design, development and implementation of CCAM solutions by CCAM developers and implementers (including decision-makers).
3. A strategy to support the fair deployment of CCAM systems and services, adapted to local contexts and cultures, leading to enhanced acceptability and willingness to use CCAM in Europe, thereby contributing to CCAM’s expected societal benefits.

4. Increased transferability of solutions, experiences, knowledge and lessons learnt between European cities, regions and projects that integrate geographical and cultural diversities in the development and deployment of CCAM.

Scope: Research on the societal implications and deployment of CCAM systems and services has mostly been “geography- and culture-agnostic”, focusing instead on mobility behaviours at demographic level and prioritising factors like age and gender. However, European countries encompass multiple cultures, historical heritage, administrative structures, and public policy approaches (e.g. on climate change, digitalisation, and road safety) which may influence the uptake and use of CCAM. The range of cultural, geographical and policy diversities need to be integrated into the design, development and deployment of CCAM solutions. Such diversities can include infrastructure (certain regions have dedicated lanes for alternative mobility solutions, strong bike cultures), specific geographical dispositions (mountains, harsh weather conditions leading to car-captivity or a centralisation of mobility services), or cultural norms and working conditions (e.g. remote working or diverging innovation-friendly or privacy-centric cultures). Furthermore, there are also regional regulatory, policy and governance structures that influence the development and implementation of CCAM or other innovative services.

Adapting to and building on these European differences and similarities will ensure a more tailored, resilient and sustainable match between CCAM solutions, people and societal needs, thereby leading to higher public buy-in and societal benefits. R&I actions will therefore provide a geographical and cultural understanding of CCAM uptake and use, with the aim of contributing to a more integrated, diverse and people centric approach to the design, development and implementation of CCAM supporting mobility equity. Intersecting social factors, such as gender, age, social origin and income level should nevertheless be taken into account, where relevant.

The proposed actions are expected to address all of the following aspects:

1. Evaluate how cultural and regional particularities have led to different transport infrastructure, societal settings, travel needs and behaviours.
2. Develop methodologies that take into account the impact of cultural and regional diversities on attitudes, demand, uptake, and implementation of CCAM solutions, early in the design and development phase. In particular, these methodologies should combine this range of diversities and be based on:
 - o Aggregation of results from existing studies and pilots that have investigated isolated diversity aspects in automated mobility contexts.
 - o A systems perspective, with specific attention on the impact of CCAM on digital equity (e.g. methods for service payment and information, access to CCAM services, avoiding the negative equity effects of CCAM services without a human driver).

3. Develop principles, criteria and recommendations for the developers and implementers of CCAM systems and services (including local decision-makers and policy makers) that foster the integration of geographical and cultural factors in the planning, design, development and implementation of CCAM through proactive and corrective measures.
4. Propose indicators and approaches to enable a fair integration of cultural and regional factors in CCAM impact evaluation frameworks to better reflect the need for CCAM to support mobility equity.
5. Develop mechanisms to transfer knowledge, e.g. maps, matrices or other instruments, to capture patterns and recurring typologies of settlements, infrastructure and travel indicators in Europe to foster dissemination of people-centric and sustainable CCAM solutions. Include documentation of lessons learnt and approaches for an iterative and long-term evolution and update of the mechanism (until 2030).
6. Demonstrate the developed recommendations and the knowledge transfer mechanism by applying them in at least four pilot activities for CCAM systems and/or services. The majority of pilots should be about shared services and should cover passenger and goods mobility, although a primary focus on either people or goods mobility is possible. The pilots can be local, regional or national but are expected to represent cultural and geographical diversity in at least four European countries.

Projects should make use of the CCAM Knowledge Base³⁰⁹ to support their findings and to share research outputs.

This topic requires the effective contribution of SSH disciplines including ethics and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. Projects should also ground their work in participatory processes to support their findings.

In order to achieve the expected outcomes, international cooperation is encouraged in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

³⁰⁹ <https://www.connectedautomateddriving.eu/>

HORIZON-CL5-2023-D6-01-05: CCAM effects on jobs and education, plans for skills that match the CCAM development, and prerequisites for employment growth (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 2.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Improved understanding of the short-, medium- and long-term employment effects (e.g. working conditions, shifts in responsibilities, future roles and driver's skills depreciation) and wider socio-economic effects (income segregation, geographic dispersion, availability of entry level jobs) resulting from CCAM deployment, taking into account the full range of professions associated with CCAM services for the movement of people and goods. This includes insight on the demand of new and updated skills, as well as plans to develop and enhance these skills in order to realise new opportunities and future needs arising from CCAM deployment.
2. High awareness within the stakeholder community about the effects of CCAM on jobs, along the entire CCAM value chain, and recommendations on how to address those effects.
3. Prerequisites for job creation and job growth through strategies that aim to boost innovation capabilities and develop competitive CCAM solutions and associated businesses.
4. Support the development of educational plans and activities (e.g. for curricula, Lifelong learning initiatives) as well as reskilling efforts to develop human capital in innovative mobility systems and services through education and training, thereby realising the benefits of a large deployment of CCAM solutions.

Scope: In order to make the socio-economic transition to CCAM fair for all, it is important to anticipate and mitigate potential job losses and job relocations due to CCAM deployment (including shared services) by ensuring that necessary skills are available and up scaled across a wide range of fields (along the entire CCAM value chain, from mobility operators, IT staff, drivers and non-drivers, to administration and management in transport). While concerns and future needs regarding the impact of automation on the transport sector have been identified and investigated^{310,311}, the potential for CCAM solutions to lead to job creation and job growth remains strong.

H2020 projects³¹² and studies³¹³ have investigated the socio-economic impacts of automation across different transport modes (air, rail, road, waterborne) in order to provide policy recommendations that keep pace of this rapidly developing mobility transition.

Building upon the findings of these projects, the proposed action will aim to further anticipate and mitigate the impacts and rebound effects on jobs due to the deployment of road based CCAM systems and services, as well as boost innovation capabilities through the availability and upscaling of CCAM-specific professional skills. A wide range of professions and fields has to be considered. In addition, proposed actions should raise the awareness of the stakeholder community to better understand and anticipate upcoming socio-economic needs and requirements (especially in terms of employment opportunities and skills) and provide support through proactive planning.

The proposed actions are expected to address all of the following aspects:

- Develop a roadmap to support the socio-economic transition to CCAM and provide prerequisites for job growth, strengthened innovation capabilities, and short- and long-term demands for skills. Future spatial mismatches in labour demand identified by existing studies³¹⁴ should be taken into account. This roadmap should consider a wide range of CCAM-related professions, especially service related, and highlight any particularities between the transport of persons and of goods.
- Define and assess how expectations for job growth enabled by CCAM development and deployment can be achieved. Identify mechanisms and options to enhance innovation capabilities to develop competitive solutions. Social innovation³¹⁵ is encouraged.
- Analyse socio-economic and employment effects of CCAM across the full value-chain, such as income segregation, geographic dispersion, workforce overcapacity/shortages,

³¹⁰ ECORYS: Study on exploring the possible employment implications of connected and automated driving. Final Report. Rotterdam, October 2020.

³¹¹ European Commission: Study on the social dimension of the transition to automation and digitalisation in transport focusing on the labour force. Final report. Brussels, 2021.

³¹² [WETRANSFORM, SKILLFULL, Pascal](#).

³¹³ In particular, work within the [Wise-ACT COST project](#).

³¹⁴ ECORYS: *ibid*.

³¹⁵ Social innovation concerns the development of new products, methods, and services for and with society to meet societal needs involving citizens, public authorities, business and industry, social partners and academia—the “Quadruple Helix”—in their design, development, and implementation to drive social change and market uptake.

considering various penetration degrees of mobility solutions with automation levels 3-5, taking into account:

- o Different operations in the transportation of people and freight.
- o Aspects induced by new emerging business models such as sharing schemes, e-commerce.
- o The role of road transport as an entry point into work-life and the effect of CCAM on the availability of entry-level jobs.
- Identify and assess short to long-term demands for updated skills (as well as skills and gender gaps) and enhanced knowledge regarding the full range of CCAM-related professions along its entire value chain, both for the mobility of persons and delivery of goods. This goes beyond jobs directly involved with vehicles (manufacturing, driving and operating) and should also include services (e.g. boarding assistance at travel end-points such as hospitals). This should include the development of educational plans and trainings³¹⁶.
- Design schemes for the development and enhancement of skills to support future CCAM jobs and innovations. This is to be done throughout educational chains by looking at different use cases, paying particular attention to potential mismatches in skills and spatial demand and supply. Consider at least three use-cases for groups of people that are directly or indirectly involved in the provision of CCAM services. A variety of angles should be covered, including young persons, gender, private and public sector, passenger mobility and freight.

This topic requires the effective contribution of SSH disciplines including ethics, gender and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. Involvement of labour market competencies is encouraged. Social innovation should also be considered to support the actions under this topic in order to match innovative ideas with social needs.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

³¹⁶ In this respect it would be advisable to establish, as appropriate, a link to project FAME funded under CL5-2021-D6-01-06 and to the future project funded under topic HORIZON-CL5-2024-D6-01-05 that are developing the EU- Common Evaluation Methodology (EU-CEM).

Multimodal transport, infrastructure and logistics

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D6-01-06: Zero-emission e-commerce and freight delivery and return choices by retailers, consumers and local authorities

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 6.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Better understanding of customers’ willingness and motivations to choose more sustainable delivery and return options, possibly including also social sustainability (e.g. adequate working conditions for drivers/delivery personnel).
- Retailers and logistics operators support relevant processes by providing information on the implications of delivery solutions.
- Consumers are aware and committed in using delivery and return strategies to reduce emissions and traffic congestion.
- Information on environmental footprint of deliveries and returns are provided transparently and in an understandable way by the retailers (in collaboration with logistics operators and transport system providers) to consumers.
- A wider range of zero-emission delivery and return options and related incentive schemes (at least comparable to the existing ones e.g. in terms of price and convenience) are co-designed with customers and proposed by retailers, incentivised by customers’ growing demand for greener choices and cities’ regulations.

- At least 50% of the delivery and return options/processes adopted by the retailers and logistics operators involved in the action and available to their customers are zero-emissions.
- Better understanding of local authorities' ability to influence greener choices of delivery and return options by consumers.
- Recommendations proposed to local authorities and the EU on the impact of relevant policy levers and possible regulations to influence greener choices of delivery and return options.

Scope: To support changing retailers and customers' behaviours towards zero-emission freight delivery and return choices, the research actions will have to develop co-created actions able to increase transparency and consumers' awareness of greenhouse gas emissions and other impacts (considering also socio-economic ones) of e-commerce, deliveries and returns. They will have also to propose zero-emission delivery solutions and develop supporting incentive schemes to encourage customers to make sustainable choices, still in accordance with their preferences and in combination with competitive and sustainable retail value propositions. The research actions will have to take into account and build on existing methods and standards to compare the emission in the transport value chain of B2C e-commerce, and to be developed in line with the Commission's initiative on EU framework for harmonised measurement of transport and logistics emissions – 'CountEmissions EU'³¹⁷.

Proposals will have to address all of the following points:

- Taking stock of existing studies, assess which conditions would make zero-emission delivery and return options attractive to consumers and which motivations and options would incentivise consumers to change their behaviour towards greener choices. Integrate an intersectional analysis of consumers' gender, age, and socioeconomic status to account better for the customers' variety of expectations and motivations and develop solutions which cater for all social groups.
- Co-designing with and engaging consumers and retailers, and taking into account the assessed motivations and incentives, develop a set of zero-emission delivery and return options, which are at least comparable with existing delivery offering and account for the different consumer groups' needs and motivations to change their behaviour. Identify which options would be more suitable to the customers' group or groups more motivated to change their behaviours and act as frontrunners, thus leading to a more rapid adoption.
- Actively involve consumers (e.g. through consumer organisations) and retailers in the development of guidelines and best practices for retailers to raise awareness and communicate transparently and in an understandable way on the greenhouse gas emission footprint of deliveries and returns' modes and options.

³¹⁷ Commission's CountEmissions EU initiative (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13217-Count-your-transport-emissions-%E2%80%98CountEmissions-EU%E2%80%99_en –

- Define scalable and generic processes and requirements for the retailers to adopt the zero-emission logistics processes in practice.
- Develop and analyse different scenarios that implement measures towards both more transparent communication and implementation of cleaner and zero-emission e-commerce last mile deliveries to assess reduction of greenhouse gas emissions and air pollution.
- Test with selected retailers and representative customers, and in collaboration with relevant local authorities, the proposed guidelines to visualise the advanced information on emissions and the zero-emission delivery and return options towards consumers. Assess their attractiveness to consumers, the potential impact on consumers' behaviours (including e.g. same-day delivery, returns and physical store pick up options) and their possible buy-in into more sustainable offering. In an iterative process develop and implement recommendations for improvement.
- Demonstrate solutions and propose recommendations to support and incentivise the uptake of greener choices by consumers and retailers.
- Define indicators to measure and evaluate the successful communication and the implementation by the retailers as well as the adoption by the consumers of zero-emission delivery and return options.
- Develop recommendations and a toolset with and for local authorities to accelerate the adoption of zero-emission delivery and return options and choices.
- Strengthen the coordination and collaboration between e-commerce companies, industrial logistics stakeholders and cities, companies, research and civil society, in Europe and internationally, to give input to the project as well as disseminate and exploit results.
- Cooperation with the network of cities CIVITAS³¹⁸ should be planned as appropriate.

If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries are expected to clearly describe if and how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions. In addition, if the activities proposed involve the use and/or development of AI-based systems and/or techniques, the technical and social robustness of the proposed systems has to be described in the proposal.

HORIZON-CL5-2023-D6-01-07: Operational automation to support multimodal freight transport

Specific conditions

³¹⁸ <https://civitas.eu/>

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Better definition of the operational automation requirements for seamless multimodal automatic freight transport.
- Clearly assessed benefits, in terms of reduced social and environmental impacts (e.g. GHG, congestion, working conditions, employment rate and safety) and reduced logistics and freight transport costs, as well as technological gaps of hubs' automation.
- Strategies to reduce the investment cost in this sector and support the implementation of automated solutions for logistics and multimodal freight transport are proposed.
- Recommendations for possible regulatory and policy actions.
- Synergies are established among rail, road, aviation, waterborne and alternative innovative modes of transport research actions on automation relevant for freight transport (e.g. links to CCAM³¹⁹ and Zero Emission Waterborne Transport Partnerships³²⁰, and EU Rail JU Flagship Areas 1, 2 and 5³²¹).

Scope: Automated vehicles, rolling stock and vessels, as well as related transshipment automated processes, are developed independently within the various transport modes and sectors. This creates gaps and disconnections in the actual use within the logistics operations, missing concrete new operational models and opportunities for end-to-end logistics, which may support adoption and contributing to system integration and decarbonisation.

³¹⁹ <https://www.ccam.eu/>

³²⁰ <https://www.waterborne.eu/partnership/partnership>

³²¹ See draft EU-Rail Multi Annual Work programme at https://shift2rail.org/wp-content/uploads/2021/12/20211222_mawp_v1_agreed-in-principle_clean.pdf

Automation will change the way goods flow across all modes (possibly encouraging modal shifts to coastal shipping modes/smaller vessel fleets, inland waterways transport, railway transport, or alternative road transport usages) and is not well explored in terms of opportunities for the logistics supply chains and enabling increased usage of vehicles and infrastructures. A high level of operational automation can be reached in terminals and hubs (e.g. node-to-node operations undertaken in inland hubs, multimodal depots, logistics terminals, freight consolidation facilities), which offer controlled environments and repeatable processes but also in the operational domain of processes occurring in those places.

To ensure operational efficiency and support multimodal transport, proposals should address all the following points:

- Identify gaps in automated transport technologies and logistics operations between modes and hubs.
- Assess benefits of autonomous vehicles, rolling stock and vessels to multimodal logistics and the role/benefits of seamless multimodal automatic cargo transport across transport modes (rail, road, waterborne, aviation, alternative innovative modes of transport).
- Investigate the requirements and define concrete benefits of seamless and automated logistics operations, particularly in multimodal terminals and hubs, linking e.g. rail, road and inland waterways with a focus on intra-European freight flows. Consider interoperability and cybersecurity issues.
- With the support of e.g. machine learning, digital twins, robotic process automation and AI, and using historical operational data, compare and demonstrate (through simulation) benefits of operational automation to current standard flows and operations in all modes. Synergies for rail will need to be sought with the EU-Rail Programme projects implementing the Flagship Areas 1, 2 and Destination 5³²².
- Design, analyse and evaluate business and governance models as well as organisational change issues and incentives to reduce the investment costs and support the implementation of automated solutions for logistics and multimodal freight transport.
- Develop and propose recommendations for possible regulatory and policy actions supporting the adoption of automated solutions for logistics and multimodal freight transport.

If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries are expected to clearly describe if and how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions. In addition, if the activities proposed involve the use and/or development of AI-based systems and/or techniques, the technical and social robustness of the proposed systems has to be described in the proposal.

³²² See draft EU-Rail Multi Annual Work programme at https://shift2rail.org/wp-content/uploads/2021/12/20211222_mawp_v1_agreed-in-principle_clean.pdf

HORIZON-CL5-2023-D6-01-08: Future-proof GHG and environmental emissions factors for accounting emissions from transport and logistics operations

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 3.00 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ³²³ .

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Establish a comprehensive set of harmonised GHG emission factors, for transport and logistics operations;
- Explore synergies and establish horizontal cooperation among various organisational structures developing GHG emission factors for transport and logistics.

Scope: Proposals should develop a comprehensive set of harmonised emission factors for the transport sector (freight and passenger), covering GHG emissions (CO₂ equivalent) of transport and logistics operations. Proposals should address values for the entire transport/logistics chain and take up the full energy lifecycle (Well-To-Wheel/Wake).

³²³ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Emission factors that relate the amount of GHG emission to the unit of energy consumed (for an energy-based calculation), or to the amount of GHG activity (for an activity-based calculation) are the basis of any GHG calculation. The increased efforts for measuring effects of climate change in various segments of the transport sector resulted in a range of values developed within the organisational structures of different transport modes, research entities and countries. Some of this work led to legitimate testing and development of the methodologies for the calculation and use of emission factors, or the generation of values that represent fuel specifications for given applications. However, much of it has merely resulted in a proliferation of apparently similar values creating confusion in the marketplace and bearing the risk of selection of sources/values purely on the basis of what is beneficial to the individual entity rather than what is correct.

This problem becomes more important in conjunction with the development of a wide set of technical solutions combating climate change, particularly the new and increasingly complex zero and low carbon energy mixes, including e- and biofuels. These solutions are deployed in the market very often with the support of dedicated financial mechanisms and programs, based on the estimated GHG emission reduction associated with the specific fuel technologies. Not only is it important for the climate impact that the emission calculations are ‘correct’³²⁴, but when dealing with large amounts of transport energy even a small difference over an emission factor value can lead to a significant difference in the associated financial transaction. Without an agreed and validated set of default emission factors for a wide range of the most common energy sources and a mechanism whereby legitimate variations or new energy carriers can be regularly updated, many actions based on calculating GHG emission reduction can be considered to be a risk of conflict and associated legal dispute.

Proposals will have to address all of the following points:

- Review the existing emission factors derived from the key global sources, duly reflecting the scientific state of the art and ensuring the coverage of new and conventional fuels.
- Perform the gap analysis and develop emission factors for categories not yet covered, both for upstream and downstream emissions, taking into due consideration new production pathways, and addressing in particular the uncertainty and variation in the well to tank factors to be applied to the new fuels.
- Establish a clearer set of rules regarding:
 1. Methodology – to ensure that the basis and legitimate use of the two fundamental methodology types (consequential and attributional) are properly understood and applied appropriately.
 2. Boundaries of calculation – to ensure that boundaries are not accidentally or deliberately set in order to favour particular outcomes.

³²⁴ There may be no such thing as a 100% correct value, but it is essential there is a consensus and linked convention based around values within an agreed, small uncertainty threshold.

3. Common sets of fuel / energy specifications – to ensure that data labels and associated values are truly aligned between sources.
4. Assumptions about input parameters that can result in variations in output values based on local circumstances for specific production.
5. The basis for new energy carriers to be calculated quickly and consistently in order to avoid delaying the deployment of new, beneficial solutions.

Establish a simple guidance to the transport sector as to which emission factors are the agreed defaults, and why; under what circumstances an alternative can legitimately be used.

The project’s main governance (e.g. Steering Group, Advisory Board) is expected to provide for direct involvement of all relevant stakeholders, as well as relevant European Commission services.

The proposal should build on the existing and emerging EU regulatory frameworks (including Commission’s proposal for the [Fit-for-55 package](#) and the new initiative on harmonised measurement of transport and logistics emissions – ‘[CountEmissions EU](#)’), GHG emissions accounting standardisation activities (such as the future [ISO standard 14083](#)) and other relevant initiatives and projects. Given that emission factors are applied in a global transport market, efforts need to be made to ensure that internationally relevant bodies such as IMO or ICAO are involved alongside prominent European stakeholders.

HORIZON-CL5-2023-D6-01-09: Climate resilient and safe maritime ports

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to ALL of the following outcomes (with a clear baseline for each use case):

- Ensure resilience of infrastructure of a) seaports, b) connected inland waterways infrastructure c) connected hinterland land infrastructure, to extreme weather events by assuring at least 80% operability during the disruptions.
- Contribute with at least 20% increase in modal shift of port hinterland connections towards zero- and low-emission transport systems.
- Ensure safe port access and port operations by avoiding extra accidents as a consequence of disruptions caused by a changing climate.
- Minimise environmental impact (e.g. emissions, soil/water pollution, degradation of ecosystems and fragmentation of habitats and biodiversity loss, as foreseen in the EU Biodiversity Strategy 2030³²⁵) during construction, maintenance, operation and decommissioning of the infrastructure by going beyond the EU environmental legislation.
- Present guidelines describing measures (structural, operational and institutional) to address climate risks and hazards, and provide guidance on how to screen and evaluate options.

Scope: Research is needed in order to limit transport infrastructure vulnerability to climate change and other natural or human caused disruptions. Making infrastructures more resilient to climate change should focus on improving the ability of the transport infrastructure network to withstand disruption, adapt to changing conditions under extreme circumstances while maintaining its performance. The goal is to strengthen infrastructure reliability, improve its performance under extreme circumstances thus increasing the resilience of the whole transport system.

Sea ports and waterways around the world are experiencing air and water temperature increases, rising sea levels, changes in seasonal precipitation and wind and wave conditions. Many are also seeing more frequent and severe extreme events such as storms, flash floods, prolonged heatwaves and droughts. Climate change represents a significant risk to business, operations, safety and infrastructure – and hence to local, national and European economies.

Extreme weather events affect transport infrastructures and their management. Even if infrastructures are designed to cope with various stresses along their life, the increase of frequency and severity of extreme weather events will, increase their deterioration pace and increase possibility of accidents that may become more frequent due to adverse weather conditions. Sea ports and connected inland waterways are particularly exposed to extreme weather events and are very important for the local and global economy, since nearly 80% of world freight is transported by ship. Seaports of Europe are gateways to other continents. 74% of extra-EU goods are shipped through ports. They are also important for intra-European

³²⁵ <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380>

trade: 37% of the intra-EU freight traffic and 385 million passengers pass by ports every year. A 50% growth of cargo handled in EU ports is predicted by 2030³²⁶

Port and waterway operators need to take urgent action to strengthen resilience and adapt. As coastal structures, seaports and connected inland waterways are exposed to storm surges and sea level rise and are vulnerable to flooding. Climate change is expected to have more severe impacts in northern Europe, where Europe's top 20 cargo seaports are located. In total, 852 ports face the risk of inundation in 2080 and the number of seaports to be exposed to inundation levels higher than 1m is projected to increase by 80% from 2030 to 2080. The number of ports that face the risk of inundation is expected to increase by more than 50% from 2030 to 2080. This trend is even stronger on the North Sea coast, where according to the GISCO database over 500 ports are located with traffic accounting for up to 15% of the world's cargo transport (EUCC-D, 2013). In total, 852 important ports face the risk of inundation by the end of the century is 852³²⁷.

At the same time when focusing at a resilient and performing transport infrastructure, its environmental footprint, resource and material consumption and habitat fragmentation and biodiversity degradation should be reduced to a minimum. The goal is smart, green, sustainable, climate-resilient and biodiversity friendly infrastructure.

Proposals will develop and validate new solutions to increase resilience, efficiency, inter-modality and safety of the transport system, for passengers and freight.

Proposals will have to address all the following points:

- Develop solutions for ensuring the performance and safety of a) seaports, b) connected inland waterways infrastructure c) connected hinterland land infrastructure, during periods of extreme weather events.
- Develop strategies minimising capacity loss of infrastructures during disruptive events, securing infrastructure assets or delivering the necessary redundancy or adaptive capacity when at the same time avoiding over-designing, adopting an inappropriate or irreversible design, based on vulnerability analysis and risk assessment.
- Demonstrate solutions to interconnect infrastructure health monitoring, traffic management and emergency management systems to support informed decision making during and after these events, also supporting possible redistribution of freight and passengers flows to complementary infrastructures. Solutions for rail to be harmonised with EU-Rail Programme projects implementing the Flagship Area 5³²⁸.

³²⁶ https://ec.europa.eu/commission/presscorner/detail/en/MEMO_13_448

³²⁷ https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108865/jrc108865_final.pdf

³²⁸ See EU-Rail Multi Annual Work programme at https://shift2rail.org/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

- Build on innovative solutions for surveillance and prediction of climate change effects, such as the Destination Earth digital twins³²⁹, and for identification of infrastructure points particularly vulnerable to climate change. Proposals should develop cross-modal strategies to upgrade (including physical upgrade) existing infrastructures and reduce their vulnerability, while using sustainable materials and construction techniques.
- Develop novel and improved governance models that enable cooperation across institutional, modal and national boundaries to cope with large-scale shocks and disruptions.
- Develop standard procedures and methodologies to foster the implementation of measures (structural, operational, institutional and social) to address climate risks and hazards. Include at least three pilot demonstrations of the proposed solutions in operational environment (minimum at TRL7) for three seaports with connected inland waterways infrastructure on CEF corridors. The pilots should select the most effective measures and combinations of measures and determine how and when they can best be implemented over time as conditions change.
- Evaluate the qualitative and quantitative impact of the proposed measures with a clear baseline for each pilot demonstration.
- Innovative infrastructure solutions should contribute to lowering the environmental footprint, resources and material consumption. Exploring Nature-based solutions (NBS) is an opportunity for creating sustainable, climate-resilient European transport infrastructure in a cost-effective manner, while producing substantial social, economic, and environmental co-benefits. The goal is smart, green, sustainable and climate-resilient infrastructure, planned in a way that maximises positive impact on economic growth and minimises the negative impact on the environment and, significant and lasting degradation of ecosystems, fragmentation of habitats or loss of biodiversity, promoting environmentally friendly modes of transport and leading to the reduction of transport emissions.

If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries are expected to describe how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions.

Proposals should also consider results from previous calls on infrastructure resilience³³⁰ construction and sustainable construction and should uptake relevant EU guidance on development and management of European transport infrastructures.

³²⁹ <https://digital-strategy.ec.europa.eu/en/activities/work-programmes-digital>, main work programme, section 5.1.1

³³⁰ FORESEE: <https://trimis.ec.europa.eu/project/future-proofing-strategies-resilient-transport-networks-against-extreme-events>
SAFEWAY: <https://trimis.ec.europa.eu/project/gis-based-infrastructure-management-system-optimized-response-extreme-events-terrestrial>

Safety and resilience

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D6-01-10: Better infrastructure safety on urban and secondary rural roads throughout a combination of adaptable monitoring and maintenance solutions

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Research is expected to contribute to all the following outcomes:

- Enhanced criteria catalogue for road safety assessment for urban and secondary roads with particular applicability for non-trunk roads and the safety impact on all – including new – types of users. Criteria can be mapped on to established safety-related Key Performance Indicators (KPIs) e.g. reduction of collisions, homogeneous driving speed, reduction of maintenance costs, etc. to provide measurable societal benefits.
- Technology for the real-time generation and communication of infrastructure Key Performance Indicators (KPIs) related to safety, including those created/derived from vehicle sensor data

PANOPTIS: <https://trimis.ec.europa.eu/project/development-decision-support-system-increasing-resilience-transportation-infrastructure>
RESIST: <https://trimis.ec.europa.eu/project/resilient-transport-infrastructure-extreme-events>
CLARITY: <https://cordis.europa.eu/project/id/730355>

- Concepts for interaction of infrastructure elements in a digitalised ecosystem for road safety resulting in measurable benefits (reduced number of collisions, reduced maintenance costs, reduced time spent in congestions, monetary economic benefits, etc.).

Scope: Road infrastructure can be improved to decrease the risk of crashes and other incidents as well as crash severity. The benefits of this will be amplified in a connected transport system where automated or partially automated vehicles are supported by infrastructure features to perform as expected. In addition, road infrastructure can provide clear guidance towards desirable road user behaviour, which may lead to more predictable behaviour, and consequently to less crashes.

It is essential to understand how to upgrade the infrastructure network to make it compatible with all road users (e.g. powered two-wheelers are not considered as users for which urban infrastructures are usually designed) and in particular with automated vehicles at different levels of automation. The research should focus on urban and secondary rural networks as most of the resources for upgrading the road network is often devoted to primary networks (with specific attention to the Trans-European Road Network). For urban and secondary roads, resources are generally limited, and potential negative impact of roadworks on the surrounding territory is extremely relevant. Low-cost interventions with low negative impact need to be studied for these roads.

Advanced monitoring, warning and maintenance techniques need to be developed to guarantee a timely assessment of the operating conditions of road structures and furniture. Recent events have highlighted the importance of roadside safety devices monitoring, but also proper signs and marking, pavement and overall road structures (bridges, tunnels etc.).

The results of the research will enhance the safety level of the infrastructure by enabling a prompt reaction to potentially unsafe conditions and will enable to identify the infrastructures where connected, automated vehicles can travel under safe conditions.

Aspects to be addressed are expected to include:

- Connection of infrastructure elements to the digitalised ecosystem, including but not limited to research on digital twins.
- Identification of criteria to perform safety assessments of urban and secondary rural roads accounting also for new users (including but not limited to powered two-wheelers, e-bikes etc.) and to identify cost effective upgrade solutions.
- Further development of infrastructure measures to elicit desired road user behaviour.
- Pilot testing of selected interventions in at least three sites.

In addition, actions should address at least three out of the following aspects:

- Integration of safety and V2I issues in asset management to ensure that the infrastructure is always capable to provide the minimum required level of performance to provide safe travel conditions for automated vehicles (ISAD concept).
- Development of new technology for monitoring and communicating in real time infrastructure distress conditions and deterioration. This should include malfunctioning and post impact warning for road equipment and Infrastructure.
- Development of onsite data storage and communication systems (e.g. RFID) capable to provide in real time details on the properties of the road equipment relevant to road safety.
- Use of data from connected probe vehicles to detect safety relevant conditions and collect maintenance indicators.
- Development of new maintenance techniques for road equipment with low negative impact on the surroundings (including but not limited to roadside safety features, signs and marking, lighting).

Actions should be based on the results of previous EU projects.

HORIZON-CL5-2023-D6-01-11: Aviation safety - Uncertainty quantification for safety and risk management

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Project results should focus to the quantification of uncertainty (UQ) in all aspects of the design, manufacturing and operations for achieving high level of safety and

a better management of risks. Project results are expected to contribute to at least three (or more) of the following expected outcomes:

- UQ for modelling/simulation of design, manufacturing and integration processes.
- UQ for operational aspects.
- UQ for virtual certification.
- Big data processing and data science for safety intelligence and risk management, including both structured and unstructured (text-based) data.
- Development of UQ (as open as possible) mathematical libraries and management Tools (e.g. tolerancing, kriging, higher order reliability methods).
- Validation campaigns in challenging test cases.

Scope: Uncertainties are always present due to limited manufacturing precision and variable operating conditions and life cycle events. Integrating these uncertainties into the design process of aircraft, aircraft engines and systems is a key element to reduce program risk and to ensure safe and economic operation.

Uncertainty is an upper bound between the estimate of aircraft characteristics and performance at a certain stage of its development and characteristics of the aircraft once in service. As such, the full lifecycle of aviation systems should be taken into account, including uncertainties occurring during manufacturing operations. This uncertainty can be the consequence of the quality of the means used during the development phase to estimate these characteristics and an inaccurate knowledge of the actual status of the aircraft, and appropriate tolerancing in the design phase. The planning and design of the current and future aviation system requires an advanced model of the interactive aviation operational system, not just of pilot or aircraft-centric operations.

Evaluation of uncertainties associated to each measurement should be the result of a detailed and justified methodology, fully taking account of the role of human factors or human agents within the aviation socio-technical system. Treatment of uncertainties enables a rigorous management of performance engagements and associated risks assessment. Traditional safety margin approaches will be replaced by engineering procedures based on sound data analysis using both mathematical modelling and knowledge engineering appropriate to both structured and unstructured (text-based) data.

As appropriate, safety risk assessment should be addressed in cooperation with EASA, notably with regard to big data processing on safety intelligence.

HORIZON-CL5-2023-D6-01-12: New ways of reducing serious injuries and the long-term consequences of road crashes

Specific conditions

<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Research results are expected to contribute to all the following outcomes:

- Validated mechanisms of personal injuries leading to significant long-term consequences, for all road users (pedestrians, bicyclists, motorcycle riders, car and bus drivers and occupants, etc.).
- Established system for classification of long-term injuries, including methods for follow-up of personal injuries for the required time after a crash.
- Validated tools and methods for the assessment of injuries leading to long-term consequences, such as upgraded virtual human body models.
- Preconditions to develop policy, regulatory, and standard requirements for the purpose of reducing serious injuries, in particular those with long-term consequences.
- A general upgrade in protection for all road users through safe and robust countermeasures and solutions.

Scope: In addition to fatal and near-fatal injuries, personal injuries with long-term consequences continue to pose a threat to personal mobility. Particularly pedestrians, bicyclists, and motorcycle riders, as well as users of new mobility devices, have a high risk to sustain personal injuries with long-term outcomes, such as brain and neck injuries. In cars, despite new collision mitigation systems, low and medium severity collisions may still cause similar permanent neurological disorders to occupants. Long-term injuries to both the upper and lower extremities are further examples, occurring among all road user types. As of today, neither any standardized nor any accepted method exists for the evaluation of solutions to reduce long-term outcomes. In addition, there is a need to include more aspects of human variability like age, sex, weight, and stature, with particular focus on long-term disability.

Several research areas, also social sciences, are required for the sake of understanding and reducing the long-term consequences fully. Cognitive capabilities could for example be impaired by physical head trauma, and there is at the same time a need for more knowledge of psychiatric impairment related to posttraumatic stress or reduced quality of life. In other words, cognitive issues and depression have to be fully recognized as potential long-term consequences of road crashes.

More research is needed to establish a relevant system for classification of long-term or permanent disability that can be used for the development and design of future protective solutions as well as policies and requirements. There is a strong need for refined knowledge of the relations between initial injury and long-term consequences of personal injury, which will demand new in-depth crash data for the reconstruction of collisions combined with long-term injury follow-up. New models for measuring long-term consequences will need a lot of real-world data to become validated. In-depth analysis of data from hospitalized patients will in this perspective also continue to be needed as well as efficient means to follow up on psychiatric impairment measurable. Hence, new efforts in accident research are required, as well as the most related social sciences (economics and psychology), further to research in biomechanics, vehicle crashworthiness, and other aspects of crash dynamics. New technologies open possibilities for gathering new types of data with higher levels of detail.

Virtual testing tools are crucial for new more efficient evaluation methods, and accordingly further development of human body models (HBM) is particularly important. The effectiveness of new systems should for instance be assessed in a wide range of crash load cases, which the current test dummies cannot support, and another possibility with the use of virtual HBM will be to evaluate integrated and adaptive safety at a significantly higher level of detail. The potential of HBM to be usable for the evaluation of long-term injuries in product development is strong and will be supported by further multidisciplinary research. Research is also needed to assess any limitations in this respect and, if applicable, examine how best to complement HBM with Anthropomorphic Test Devices and physical tools.

Virtual methods with HBM should not only be developed further for passenger car safety, but for the purpose of assessing personal protection equipment, forgiving road infrastructure (including road surfaces), and the protection of motorcycle, moped and bicycle riders, as well as pedestrians and users of new micro-mobility devices against long-term injuries. Virtual HBM need to reflect human variability, and there is a particular need to focus attention on children in all different road user roles, e.g. preteens in passenger vehicles who normally are not seated in child seats, yet often too small to be fully protected by current vehicle integrated safety systems.

New and upgraded vehicle interiors (including non-conventional seating and new interior features) of highly automated passenger cars, shuttle buses (including minibuses), and other driverless passenger vehicles, will play an important role in the efforts to raise the road safety level further regarding passenger vehicles. Persons who are standing, for instance passengers in public transport, should also be included. Market drivers (e.g. increased automation,

comfort, and infotainment) will be reinforced with safety-intended development strategies when supported by relevant research and policies regarding long-term consequences.

Research within this field is expected to recommend upgrades to concerned policies, regulatory requirements, and standards. For this reason, international cooperation is recommended.

Findings, knowledge, and experience are encouraged to be shared with other fields, such as certain sport, recreation, and work activities, as well as with other transport modes, which may have similar issues regarding personal injuries with long-term consequences as road traffic, although a different incidence.

Actions should take into account the results of previous EU research projects in that domain (e.g. Seniors, VIRTUAL, SafetyCube).

Integration of relevant expertise from social sciences and humanities (SSH) and international cooperation with partners from the US and/or Australia is encouraged.

Cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D6-01-13: Support for dissemination events in the field of Transport Research

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 1.50 million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions

	under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ³³¹ .
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Expected Outcome: Project’s results are expected to contribute to all of the following expected outcomes:

- Higher visibility, political and strategic relevance of the transport sector and of the EU policy in the field;
- Enhanced dissemination, communication and valorisation of transport R&I objectives, perspectives, strategies and results;
- More effective links and exchanges between research and innovation stakeholders and policy makers, to support the development and deployment of innovative solutions in Europe;
- Increased attractiveness of transport related studies and reinforce the pursuit of excellence in European transport research and innovation, by giving recognition and visibility to the best achievements.

Scope: Actions should address the activities of both Part A and Part B:

Part A: The action will prepare and provide support to the Transport Research Arena conference (TRA) to be organised in 2026 gathering transport stakeholders for discussing political, industrial and research issues on a European and global level.

Proposals are expected to demonstrate the financial and organisational support of the national authorities' and a preliminary economic plan covering the additional funding needs. In order to ensure high political and strategic relevance, preference will be given to proposals involving Member States holding the Presidency of the European Union in year 2025, 2026 or 2027.

In line with previous TRA biannual conferences, the event should address the technological and industrial developments of the transport sector (road, rail, waterborne, aviation sectors and cross-modal aspects) providing a high level, future oriented perspective coming from politics, the industry and the research community, in response to Europe’s social needs and expectations.

In collaboration with the relevant actors, such as the European Commission services, the different European Technology Platforms (ERTRAC for road, ERRAC for rail, WATERBORNE TP for waterborne, ALICE for logistics and ACARE for aeronautics and

³³¹ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

ECTP for construction), the Conference of European Directors of Roads (CEDR), the European Transport Research Alliance (ETRA), relevant transport-related European partnerships, such as 2ZERO, CCAM, EU-Rail, ZEWT and Clean Aviation and the previous TRA conference organisers in order to maintain continuity, the action will define the overall planning of the conference, structure the technical and political sessions of the event, contribute to select the appropriate location for the venue and offer operational IT tools for the registration of participants, the handling of speakers' contributions, contribute to the organisation of logistics, etc. Support to the organisation of demonstration activities should also be foreseen.

Specific attention should be put on a broad and balanced participation i.e. students, young researchers, women, a large number of countries' representatives, etc.

Part B: The proposal is expected to also organise two competitions for transport research and innovation awards covering all transport modes and cross-cutting issues (technological, socio-economic and behavioural aspects) in line with the EU policy objectives for climate-neutral and environmentally friendly mobility:

- A competition for students and young researchers with the goal of stimulating the interest among young researchers/students in the field of transport;
- A competition for senior researchers in the field of innovative transport concepts based on results from EU-funded projects only.

The organisation of these awards should ensure high-quality competition and very good media coverage before, during and after the TRA conference, in line with previous editions (TRA Visions). The competition is expected to give particular attention to gender issues.

Call - Safe, Resilient Transport and Smart Mobility services for passengers and goods

HORIZON-CL5-2024-D6-01

Conditions for the Call

Indicative budget(s)³³²

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR	Indicative number of

³³² The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

Horizon Europe - Work Programme 2023-2024
Climate, Energy and Mobility

		2024	million) ³³³	projects expected to be funded
Opening: 07 May 2024 Deadline(s): 05 Sep 2024				
HORIZON-CL5-2024-D6-01-01	RIA	12.00	Around 6.00	2
HORIZON-CL5-2024-D6-01-02	RIA	14.00	Around 14.00	1
HORIZON-CL5-2024-D6-01-03	IA	12.00	Around 6.00	2
HORIZON-CL5-2024-D6-01-04	RIA	10.00	Around 5.00	2
HORIZON-CL5-2024-D6-01-05	CSA	4.00	Around 4.00	1
HORIZON-CL5-2024-D6-01-06	RIA	10.00	4.00 to 5.00	2
HORIZON-CL5-2024-D6-01-07	IA	20.00	Around 10.00	2
HORIZON-CL5-2024-D6-01-08	IA	15.00	Around 5.00	3
HORIZON-CL5-2024-D6-01-09	RIA	3.00	Around 3.00	1
HORIZON-CL5-2024-D6-01-10	RIA	8.50	Around 4.00	2
HORIZON-CL5-2024-D6-01-11	RIA	7.00	3.00 to 3.50	2
HORIZON-CL5-2024-D6-01-12	RIA	7.00	Around 3.50	2
Overall indicative budget		122.50		

General conditions relating to this call	
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Award criteria</i>	The criteria are described in General Annex D.

³³³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

<i>Documents</i>	The documents are described in General Annex E.
<i>Procedure</i>	The procedure is described in General Annex F.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.

Connected, Cooperative and Automated Mobility (CCAM)

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D6-01-01: Centralised, reliable, cyber-secure & upgradable in-vehicle electronic control architectures for CCAM connected to the cloud-edge continuum (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

- New, centralised, reliable, cyber-secure and upgradable in-vehicle electronic control architectures for CCAM based on the application of co-designed hardware, software and big or smart data flows in combination with over-the-air updates.

- Widespread deployment of level 4 automation in road vehicles by expanding the Operational Design Domains (ODDs) of the control system towards higher complexity (city traffic, adverse weather conditions etc.) or greater scale.
- Safe operation of Connected and Automated Driving (CAD) functions e.g. regarding Vulnerable Road Users (VRUs) and ODD transitions through system agility, experience-based decision making and access to cloud intelligence.
- Paradigm shift from human-based and component-supported vehicle control to a more integrated, resource efficient and reliable system for the control of CCAM systems.
- Strengthened cooperation of European OEMs and suppliers to co-design a standard cyber secure electronic architecture layout with harmonised interfaces.

Scope: Since current on-board electronic systems are assembled from various controllers in a piecemeal fashion, they are not suitable for the complex, combined performance requirements of advanced levels of CCAM applications in terms of bandwidths, latency, flexibility, fail safety and cyber security. Therefore, a complete redesign of the in-vehicle control architecture is needed, combining innovations at hardware, software and data levels in the vehicle and in connection with distributed intelligence in the edge-cloud continuity. It should build on a centralised e.g. zonal or domain-based layout using distributed high-performance computing for connecting sensing and actuation systems with software updates over the air, big data flows and AI at the edge, resulting in a novel and upgradable electronic in-vehicle control scheme for safe and efficient automated driving functions and tele-operations.

Important building blocks for the in-vehicle control architecture include sensors and sensor data fusion for environment perception with AI “at the edge”, using on-board high-performance computers and generic hard- and software including cyber secure components.

At the same time, the new control architecture and its context aware building blocks are expected to enable the following:

- reliable, low-latency and high-bandwidth data communication for automated driving systems control to safeguard against cyber-attacks, malfunctions and malicious interactions.
- systemic functionality gains in upgradability, efficiency, modularity, compatibility, scalability, fail-operation, reliability and redundancy.
- definition of safety and security targets, open-source standard layouts and harmonised validation methods.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D6-01-02: Scenario-based safety assurance of CCAM and related HMI in a dynamically evolving transport system (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 14.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 14.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

1. Safe scaling up of the deployment of CCAM systems for all levels of automation, including systems that for part of the driving phases rely on human-machine interaction.
2. Assurance of vehicle safety despite system changes, e.g., due to software updates and data exchanges between vehicles and the infrastructure.
3. Facilitating the introduction of fast developing technological innovations in the CCAM system’s functionality, such as AI.

Scope: To ensure the safety of CCAM, it is essential that vehicles are not only safe during the (first) type approval, but also during their complete lifetime in a fast-changing road transport system. Changes can result from the evolution of the CCAM system itself, for example, as a result of increasing connectivity using V2X communication, the use of AI-based systems, and OTA (over-the-air) software updates. The traffic system, in which CCAM systems are being deployed, is changing at a rapid pace as well, with an increased market share of vehicles with

higher levels of automation, new (personal) mobility devices and autonomous mobility robots (e.g., for package delivery).

At the same time, the way CCAM systems interact with humans in traffic is changing. Until full automation in transport is reached, the human driver will keep on playing an essential role. Also, the interaction with other road users will change, supported by technologies that allow a CCAM system to communicate its intentions to other road users.

As a consequence of these innovations and developments, the safe deployment of CCAM systems needs an extension of the safety validation procedures and certification schemes, taking advanced human-machine interaction and a continuous in-service monitoring approach into account. Due to the many different scenarios and variations that can occur realistically and that consequently need to be tested, it should be possible that a large part of the assessment is performed in a virtual simulation environment.

The proposed actions are expected to address all of the following aspects:

1. Developing a validation methodology for scenario-based safety assurance of AI-based CCAM functions. Trustworthiness of the AI-algorithms depends on how well the system responds to scenarios in its Operational Design Domain (ODD) – specificity and how it responds in case it ends-up outside its ODD – robustness. Consequently, methods need to be developed on the use of scenarios to describe the ODD of AI-based systems.
2. Connectivity. Developing validation procedures for CCAM systems that rely on V2X for safety-critical functions i.e., the inclusion of the connectivity context. Ensuring aspects of reliability, trustworthiness and cyber-security with respect to V2X is essential. The approach to V2X connectivity is technology neutral.
3. Continuous Safety Assurance approach. Developing an approach for a continuous safety validation methodology, to monitor the safety state of deployed CCAM systems in operation (real traffic) during its service life, following type approval. Performance metrics for the reliability of the monitored data, including cyber-security aspects, and indicators for the safety state should be proposed. Also needed is the development of requirements for the monitoring system for use in future standardisation, regarding the exchange of data and safety performance indicators with service organisations and authorities.
4. Validating the virtual approach. Developing tools that ensure the relevant degree of detail and the appropriate representation of other road users' behaviour (incl. Vulnerable Road Users such as pedestrians and/or bicyclists) in virtual scenario-based testing. This includes methods to deal with perception, localisation, and world modelling errors in the validation procedures.
5. Human Machine Interaction. Developing a safety assurance methodology that incorporates the assessment of Human Machine Interaction (both driver-vehicle and vehicle-road user) concepts for higher levels of automation (conformity checks as well as test set-ups with suitable metrics) ensuring safe communication between driver and

vehicle and between vehicle and other road users, making Human Machine Interaction inclusive (i.e. in terms of age, mental and physical ability, cultural aspects, etc.).

Proposed actions are expected to develop recommendations for harmonisation and standardisation and to feed into on-going discussions regarding EU type vehicle approval rules as well as in the framework of the UNECE.

Actions should be based on the outcomes of previous methodologies developed in HEADSTART³³⁴, as well as research funded under HORIZON-CL5-2021-D6-01-02³³⁵.

Upcoming CCAM projects, in particular in the area of large-scale demonstrations, validation, digital infrastructure and key enabling technologies should be taken into account to ensure compatibility.

Links should be established with the Mobility Data Space initiatives from Digital Europe, federated data infrastructure projects (Gaia-X, International Data Spaces, Big Data Value - BDV).

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D6-01-03: Orchestration of heterogeneous actors in mixed traffic within the CCAM ecosystem (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 12.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

³³⁴ <https://www.headstart-project.eu/>

³³⁵ [“Common approaches for the safety validation of CCAM systems”](#)

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. System approach towards traffic management that integrates the operations and needs of a wide range of road network users (vehicle drivers, passengers and different kinds of VRUs) traffic management centres and public authorities as well as service providers, (public transport/commercial/logistics fleet managers, infrastructure industry) within the mobility ecosystem.
2. Safer, more efficient and sustainable traffic management through the orchestration of heterogeneous actors in mixed traffic³³⁶ within the CCAM ecosystem.
3. Proven orchestration schemes in traffic management for operations of all types of vehicles and the different CCAM systems in real-time CCAM traffic conditions in urban and/or motorway environments.
4. Governance and operational models that allow for better cooperation and collaboration of all relevant actors in the orchestration of traffic management through new mobility management for all modes and road types.
5. Mobility management tools to seamlessly integrate CCAM systems and services including fleets of vehicles, public transport, logistics operations, demand management needs as well as governance and business models into the transport system.
6. Strategic transport planning methods for all modes in the CCAM ecosystem including individual as well as public transport.

Scope: The aim is to advance on the orchestration of heterogeneous actors in mixed traffic by building on, linking and integrating the following streams of research results and innovation challenges³³⁷:

³³⁶ The term ‘heterogeneous actors’ comprises the heterogeneity of Road actors such as fleet managers, service providers, traffic managers, individual vehicles, Public Transport operators and users, Road operators and contractors and VRUs. Their actions differ due to their position in the ecosystem, their objectives and behaviour, which have an impact on traffic flow and other actors in the road network). The term ‘mixed traffic’ refers to different levels of vehicle automation (including human driven vehicles) present in the road network. Orchestration of heterogeneous actors in mixed traffic takes place when the managing authorities take the needs and plans of all relevant actors into account when planning and directing traffic flows in the system also balancing the priorities set by the public.

³³⁷ CCAM Partnership, [Strategic Research and Innovation Agenda](#) 2021-2027, December 2021, [Lessons Learned](#) from completed projects, [Horizon Europe Work Programme 2021-2022](#), Climate, Energy and Mobility, *European Commission Decision C(2021)4200 of 15 June 2021*, SOCRATES 2.0: [Connecting Europe Facility \(CEF\) 2016-EU-TM-0148-S 2017](#), [TM 2.0 Innovation Platform on interactive traffic management](#).

1. Smart routing and interactive traffic management using connectivity and C-ITS for the orchestration of heterogeneous actors in mixed traffic within the CCAM ecosystem³³⁸.
2. Solutions for ensuring the safety and efficiency of early CCAM deployment in the interaction of drivers, riders, passengers, traffic participants and automated systems performing driving tasks in mixed traffic³³⁹.
3. Coherent approach towards managing fleets from an overall system perspective in real-life urban demonstrations of CCAM via testing and demonstrations in large sets of traffic environments with an emphasis on different fleets, i.e. groups of vehicles (including e.g. public transport/commercial/logistics fleets, fleets operated by public or private transport operators) that are typically controlled/supervised/managed by heterogeneous actors³⁴⁰.
4. New governance and operational models facilitating the orchestration schemes of traffic management that are inclusive towards all heterogeneous actors in traffic management³⁴¹.

Proposed actions will develop and demonstrate an orchestration scheme for traffic management energy according to priorities set by traffic authorities (including targets) that will facilitate the coexistence of heterogeneous actors or fleets on the road network (individual vehicles, public transport, Vulnerable Road Users) as well as, at different levels of vehicle automation (including human driven vehicles) in mixed traffic. Actions should contribute to the transformation of traffic management from managing traffic volumes to the management of vehicles (or even travellers) taking benefit from the advantages of fleet management (groups of vehicles that share the same attributes). Vehicles should be considered in their different sizes and usages, as well as by the mobility service they provide (private, public, shared, pooled etc.). Proposed actions should address both the transport of people and goods within automated fleets (commercial/logistics fleets, fleets operated by public or private transport operators) and individual vehicles (CCAM- or conventional vehicles, including micro-mobility) that are well integrated in the entire traffic management system.

Proposed actions are expected to develop and demonstrate orchestration schemes for operations in mixed traffic by addressing all of the following aspects:

³³⁸ Building on the results of SOCRATES 2.0 pilots reflecting the TM 2.0 concept on smart routing and interactive traffic management.

³³⁹ Expanding on the results of Horizon 2020 projects (such as CoExist, TransAID, INFRAMIX, MAVEN). While the solutions above should be embedded in a technology-neutral approach, actions should ensure that future technological options such as photonics applications (Photonics Partnership “Green and efficient lighting for future mobility”) are also addressed, if possible.

³⁴⁰ Expanding on the results of the projects of SHOW and HiDrive.

³⁴¹ Building on the work and results of SOCRATES 2.0 and TM 2.0 as well as expanding on the results of the projects being funded under HORIZON-CL5-2022-D6-01-04: Integrate CCAM services in fleet and traffic management systems (CCAM Partnership).

1. Defining the comprehensive requirements (including data exchange) for the orchestration schemes with regards to the heterogeneous actors in mixed traffic (automated and non-automated traffic, people and goods and different modes).
2. Developing traffic management tools that are essential for the coordination of mixed automated and non-automated mobility. These management tools should be robust and able to address uncertainty due to uncertain technological developments, performances, services and business cases that go beyond what is available through current research results. Tools should support orchestration by, among others, integration of ad-hoc and manoeuvre coordination (SAE cooperation classes³⁴²), efficient route guidance and capacity aware demand management.
3. Defining and demonstrating business and governance models (including for public actors) for the orchestration of traffic management in real-time CCAM traffic conditions in urban and motorway environment, allowing actors to address their needs on a win-win basis.
4. Developing measures and KPIs to demonstrate the benefits and added value of orchestration for traffic management actions (in terms of traffic efficiency, energy efficiency, safety etc.).
5. Demonstrating a process that ensures trust in the traffic orchestration scheme proposed as well as sufficient accessibility to quality data for all traffic actors involved and readiness for large-scale demonstration actions.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs³⁴³.

HORIZON-CL5-2024-D6-01-04: AI for advanced and collective perception and decision making for CCAM applications (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

³⁴² [SAE J 3216](#), Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles.

³⁴³ ‘Sustainable Urban Mobility Indicators’, as well as other published impact evaluation methodologies such as the EU-CEM, should be used to evaluate the impact of the solutions as appropriate.

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

- Approaches for resilient collective awareness, which can eventually be used in e.g. complex models of collective behaviour.
- Advanced collective awareness, decision making and triggering of actions for CCAM applications, enabled by new concepts and tools built on advancements in Artificial Intelligence (AI), including Hybrid Intelligence (HI).
- CCAM solutions evolving from reactive into predictive system state awareness (including driver state and road user diversity), decision making and actuation, enhancing road safety.
- Understanding of AI-related ethical issues and user needs, together with capabilities, limitations and potential conflicts of AI based systems for CCAM, including a definition and a measure of human-like control.
- Increased user acceptability and societal benefit of CCAM solutions, based on explainable, trustworthy and human-centric AI. Interactions with AI-based vehicles are understandable, human-like and reflect human psychological capabilities.

Scope: Today’s mobility landscape is rapidly changing, as is seen in the recent boom in the detection of advanced and/or complex urban scenarios that add new challenges to the development of CCAM technologies. These novel scenarios are especially emerging with the establishment of new urban traffic regimes and cultures, such as restricted zones, shared zones, and cycle-streets, which need to be taken into account when designing and developing CCAM solutions.

To integrate and tackle complex traffic scenarios, CCAM technologies will require highly advanced decision-making based on enhanced collective awareness – the stage beyond on-

board perception, advancing on e.g. results from projects under CL5-2022-D6-01-05³⁴⁴ – incorporating information from multiple sources and including interpretation for the aggregation of this information. Developing collective awareness should take into account the state of the vehicle, the driver and the road user environment. It can also involve the tracking of other road users' behaviour and generating predictions on a short horizon, which can be based on the input from advanced behavioural models, e.g. those developed within CL5-2022-D6-01-03³⁴⁵ projects. The integration of these findings will lead to collective awareness for CCAM.

The use of multiple sources (sensors and sensor fused information, maps, infrastructure, other road users, and localisation systems) and the sharing of the overall situational information and related intentions of the vehicle and that of its direct environment will be an important building block towards collective awareness. Eventually, in future work this can be incorporated in complex, self-organised bottom-up models of collective behaviour based on the change/modelling of individual interactions. Collective awareness should create a larger time window in safety critical situations and generate benefits for the overarching mobility system, which include efficient traffic management and improved traffic flow as it incorporates situation prediction capabilities and environmental benefits (which can eventually include e.g. smart charging strategies).

AI is a key enabler to bring these increasing amounts of information together, with decision-making enabled both at vehicle level (including safety critical decisions) and at a mobility system level. In order to continue to define the role and limits of AI and of emerging new developments within AI, this topic recommends exploring Hybrid Intelligence (HI) as such a new subset of AI. Hybrid Intelligence is the process of developing and mobilising Artificial Intelligence (AI) to expand on human intelligence and expertise, thereby ensuring human-like control of CCAM operations. Applying an HI approach will allow CCAM technologies to integrate human expertise and intentionality into its decision-making in order to generate meaningful and appropriate actions that are aligned with ethical, legal and societal values. This will be essential to foster user acceptability, trust and adoption, especially when appropriate SSH expertise is included.

Proposed R&I actions are expected to address all of the following aspects:

1. Methods to establish collective awareness of CCAM applications that are resilient to faulty sources, thereby ensuring safe operations. Guidance for failsafe designs should be developed.
2. Methods to embed an HI approach in the entire action chain towards collective awareness (from basic perception to driving functions) to allow for seamless operation and real-time decision-making while enabling human-like control of CCAM applications by combining system and domain knowledge (of the vehicle and its technologies on one hand and of the transport environment including all the human interactions on the other,

³⁴⁴ [“Artificial Intelligence \(AI\): Explainable and trustworthy concepts, techniques and models for CCAM”](#)

³⁴⁵ [“Human behavioural model to assess the performance of CCAM solutions compared to human driven vehicles”](#)

thereby understanding of potential risks and capabilities and needs of other road users). Tooling will be required to deliver situational awareness information in a structured way, based on multiple sources and in real-time. In addition, the development and integration of ethical goal functions to support collective awareness should be included. Work is expected to be based on:

- o At least perception systems, sensor fusion, high-level world models/maps, vehicle positioning information. Guidance on common reference systems for positioning and time for synchronisation should be included in order to secure robustness and traceability.
- o Relationships between the vehicle and forecasted intentions of other road users (e.g. a pedestrian crossing the street at a zebra crossing), as such including spatial temporal relation of elements in the driving-situation.

This topic requires the effective contribution of SSH disciplines including ethics and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Proposals should monitor and align relevant developments under this topic with on-going discussions regarding EU type vehicle approval rules as well as in the framework of the UNECE.

In order to achieve the expected outcomes, international cooperation is encouraged in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

HORIZON-CL5-2024-D6-01-05: Robust Knowledge and Know-How transfer for Key-Deployment Pathways and implementation of the EU-CEM (CCAM Partnership)

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 4.00 million.
<i>Type of Action</i>	Coordination and Support Actions

<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025).³⁴⁶.</p>

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

- Extended and up to date CCAM Knowledge Base³⁴⁷, including CCAM projects, demonstration and deployment initiatives, standards, facilitating the exchange of best practices and the deployment of CCAM services.
- Well established network of experts and forum for stakeholders in the different thematic R&I fields of CCAM.
- Strong collaboration and cooperation between all CCAM stakeholders through effective collaboration mechanisms fostering exchanges of practices, experiences, tools and methodologies supporting the transition to large-scale deployment.
- Increased and high-quality exchanges and cooperation between the EU Member States/Associated countries,
- EU CCAM common evaluation methodology (EU-CEM) widely used in Europe.
- Good level of understanding and awareness of CCAM among citizens, decision and policy makers in Europe.

Scope: A common basis for CCAM Knowledge in Europe is available today with the online CCAM Knowledge Base which constitutes a one stop shop for all relevant R&I initiatives, tools, methodologies, regulations and standards in the field. Targeted content will be available

³⁴⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

³⁴⁷ <https://www.connectedautomateddriving.eu>

for some stakeholder categories³⁴⁸. The Knowledge Base should be expanded and further adapted to the needs of all relevant stakeholders. Results and lessons learned from the EU, national and international projects should be made available and accessible to targeted user groups. Proposed actions should in particular provide support for stakeholders to move into operations by identifying key building blocks and standards for deploying pilot services and enable capacity building for key actors of different use cases /applications domains as well as for citizens and non-experts on how to use CCAM systems and services and to become aware of new developments and related risks.

The EU Common Evaluation Methodology (EU-CEM) developed in project “FAME” funded under CL5-2021-D6-01-06³⁴⁹ aims at becoming the basic methodology for all CCAM related evaluations to support collaboration, exchange and harmonisation. The methodology will need to be implemented for existing and innovative use cases by CCAM projects and aligned with national mobility strategies and approaches. Training programmes for CCAM projects will be necessary to integrate the methodology and to collect feedback on lessons learned during its implementation.

A States Representatives Group (SRG)³⁵⁰ has been created within the CCAM Partnership to ensure a continuous dialogue at European and national level for the sharing of information on CCAM R&I to increase coordination between European and national R&I funding schemes, and among national programmes. To carry out its mission efficiently, the SRG will need support to collect and analyse information on national R&I initiatives and to implement cooperation activities.

To successfully contribute to the expected outcomes, proposed actions are expected to address all of the following aspects:

1. Ensure the maintenance and expansion of the Knowledge Base to support the CCAM stakeholder community and CCAM Partnership for the identification of future needs for R&I, testing and demonstration initiatives and for moving into operations (minimum block requirements, standards and common definitions to run pilot services across Europe). The content of the Knowledge Base should support the monitoring of the progress made on the targets and impacts set by the CCAM Partnership³⁵¹.
2. Identify further needs for targeted content for specific stakeholder categories and in particular, develop content that is accessible to non-experts, thereby supporting capacity building of the general public. The proposed action should define the above-mentioned stakeholder categories, and develop a subsequent communication strategy (content, material, media, etc.) using realistic and accessible terms to address different target groups (including non-experts).

³⁴⁸ Outcomes of the project resulting from the call CL5-2021-D6-01-06: [Framework for better coordination of large-scale demonstration pilots in Europe and EU-wide knowledge base.](#)

³⁴⁹ Ibid

³⁵⁰ <https://www.ccam.eu/what-is-ccam/governance/ccam-states-representatives-group/>

³⁵¹ See KPI included in the [SRIA](#)

3. Provide effective dissemination and concertation mechanisms and means for the stakeholder community (e.g. conferences, workshops, international cooperation, capacity building content for non-experts) to enable the exchange of experiences and practices, stimulate collaboration and cooperation between all CCAM stakeholders and reach consensus on challenges and future R&I needs within the thematic clusters of the European Partnership.
4. Facilitate the work of the CCAM SRG and stimulate the cooperation between EU Member States/Associated Countries for improved coordination of activities in the areas identified as priorities by the SRG. Provide an analysis of initiatives in EU Member States/Associated countries and support the SRG in identifying areas for R&I cooperation.
5. Ensure representation of European stakeholders in international cooperation, information exchange and harmonisation initiatives on CCAM. Provide a global output on CCAM activities to support the development of European agendas by exploring potential opportunities and R&I domains for international cooperation.
6. Continue to evaluate and update the EU-CEM through targeted discussions with EU Member States/Associated countries in order to align the CEM with national mobility strategies and regulations, also looking at both national and regional transport and mobility data to ensure compatibility.
7. Support the practical implementation of the EU-CEM (for existing and innovative use-cases) and provide training programmes for CCAM projects to integrate the methodology.
8. Assess the level of awareness and attitudes of European citizens, decision- and policy makers about CCAM as well as their intention to use through regular surveys and workshops. Results should be published in the Knowledge Base and mechanisms should be provided to integrate findings into the EU-CEM. A link should be established with existing survey initiatives in place at EU and Member States'/Associated countries' levels. This action should be grounded in a co-creative process.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on 'Connected, Cooperative and Automated Mobility' (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership 'Connected, Cooperative and Automated Mobility' (CCAM) in support of the monitoring of its KPIs.

Multimodal transport, infrastructure and logistics

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D6-01-06: Optimising multimodal network and traffic management, harnessing data from infrastructures, mobility of passengers and freight transport

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 10.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least 4 of the following expected outcomes:

- Optimised multimodal transport network and traffic management, for efficient door-to-door mobility of passengers and freight (from producers to last mile deliveries).
- Validated solutions for effective and secure data exchange across all modes of transport, for dynamic and responsive multimodal network and traffic management.
- Validated systems for accurate detection and resolution of network bottlenecks, improving safety, security, resilience and overall performance of the transport network, enabling pro-active mobility management.
- New tools and services for optimising mobility of passengers and freight, in cities and other areas, cutting traffic jams and improving multimodal traffic flows. The proposed solutions should demonstrate (e.g. through simulations, pilots) the potential to reduce by at least 30% the average travel delay, as well as the overall transport energy consumption and emissions of greenhouse gases and other pollutants in the network.
- Workable governance arrangements for multimodal transport network and traffic management, in view of further supporting regulatory and policy actions.

Scope: Optimised multimodal network and traffic management is essential for an efficient transport network and seamless door-to-door mobility of passengers and freight. Such advanced capabilities need to be supported by harnessing data from physical and digital infrastructures, as well as from the mobility of passengers and freight, involving different types of vehicles, rolling stock, aircraft and vessels (including zero-emission, connected and automated), technologies and the use of innovative services. At the same time, novel forms of mobility (e.g. shared, micro-mobility or even hyperloop) and new services (e.g. Mobility as a Service) present new challenges, but also great opportunities for enhanced management and optimisation of the transport network. This includes advances to fully utilise dynamic and interoperable data exchange from multiple actors and transport modes, for well-tested and validated systems and operations, with appropriate governance arrangements in place.

In this context, building on best practices (technological, non-technological and socio-economic), ongoing projects on multimodal network and traffic management, as well as other initiatives (e.g. the Digital Transport and Logistics Forum and the common European mobility data space), actions should address at least 6 of the following aspects:

- Developing and testing new generation multimodal, flexible, agile and adaptable, secure and resilient transport network and traffic management systems, leveraging state of the art technologies (e.g. artificial intelligence, big data, edge computing, internet of things, blockchain).
- Assessing and simulating the effects on multimodal network and traffic management of new forms of mobility (e.g. zero-emission, connected and automated vehicles and vessels, car sharing/pooling, active-/micro-mobility, sustainable land/air transport modes and drones), as well as of innovative services (e.g. Mobility/Logistics as a Service), in different urban and rural environments, considering the socio-economic acceptability and different user needs (including vulnerable and gender groups).
- Performing simulations for network-wide optimisation of traffic models, aiming towards a “social optimum” and an evaluation of mobility options for multimodal mobility and freight flows (including last-mile), enabling a modal shift to more sustainable modes (leveraging public transport), while addressing planned and unplanned events of mobility and freight systems under disruption.
- Demonstrating the collection, aggregation, analysis and use of network-wide data from infrastructures, vehicles/vessels and users (using ICT and EU satellite-based systems), from across transport modes (modal and intermodal data), stakeholders and national borders, while preserving data privacy, security and confidentiality to data providers, thereby enabling effective and intelligent multimodal network and traffic management, and even further data exchanges with other sectors (e.g. energy and telecoms).
- Performing early pilot activities on multimodal network and traffic management of limited scale in mobility hubs (e.g. rail nodes, maritime or inland ports), where cross-modal or hinterland inter-connections are present for passenger and freight traffic flows.

- Designing and testing innovative multimodal network and traffic management services, offered by public and/or private stakeholders, which can be operated at network centres (e.g. at cities or hubs) and/or at decentralised level (e.g. by users or vehicles/vessels themselves).
- Developing and showcasing workable governance and dynamic incentive models, for the effective engagement of public and private stakeholders in interoperable data exchange, in the optimisation of transport network and traffic management and in promoting a better use of (public) transport systems.
- Evaluating the qualitative and quantitative impact of the proposed measures and project results, including on reducing travel delay, transport emissions and energy consumption, with a clear baseline for each use case.

If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries are expected to describe if and how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions. In addition, proposals should describe the technological and societal readiness of the systems and/or techniques proposed for development and use, particularly in the case of systems based on Artificial Intelligence.

The multimodal aspects listed above are complementary and in synergy with actions foreseen in other parts of the Work Programme, such as in the areas of C-ITS (as part of Connected, Cooperative and Automated Mobility), rail traffic management (as part of EU-Rail Joint Undertaking), air traffic management (as part of SESAR 3 Joint Undertaking) and vessel traffic management (as part of Zero-Emission Waterborne Transport).

In line with the Union’s strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL5-2024-D6-01-07: Scaling up logistics innovations supporting freight transport decarbonisation in an affordable way

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 20.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation

	and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Reduced greenhouse gas emissions by 55%³⁵² by 2030 in the project networks, without reducing the overall performance of the logistics supply chain and taking account of all costs and externalities.
- Gains in terms of operational efficiency and environmental impact from the implementation of the Physical Internet³⁵³ are clearly identified, demonstrated and measured.
- Logistics concepts speeding up freight decarbonisation and adoption of zero emissions vehicles/vessels and multimodality are developed.

Scope: Building on previously funded projects and ongoing activities (e.g. Connecting Europe Facility, Horizon 2020 and Horizon Europe projects), ensuring compliance with the data sharing framework pursued by the Digital Transport and Logistics Forum (DTLF), and taking into account the development of the common European mobility data space, proposals will pilot, demonstrate and scale up systemic collaborative solutions regarding logistics nodes, multimodal logistics networks connectivity, business and governance models. The focus will be on both digital and physical interoperability as well as on the adoption of zero-emission vehicles/vessels.

Proposals will have to research and demonstrate in a structured and systemic way all of the following points:

- Demonstrate at least 10 working open standard processes, procedures and services across several logistics nodes providing seamless access to users. Processes, procedures, and services are expected to have an open access definition and scalability aspects need to be addressed.
- Develop and demonstrate further compatibility and interoperability of the full range of standardised multimodal transport units (from containers to boxes), also across transport modes.

³⁵² In line with the 2030 Climate Target Plan the baseline for the greenhouse gas emissions reduction is at least 55% below 1990 levels.

³⁵³ "The Roadmap to the Physical Internet" was developed in the frame of the EU-funded project SENSE, ref. http://www.etp-logistics.eu/wp-content/uploads/2020/11/Roadmap-to-Physical-Intenet-Executive-Version_Final.pdf

- To achieve scalable multimodal logistics networks connectivity, demonstrate models and processes, supported by Artificial Intelligence, Internet of Things, etc., which can increase utilisation of assets and resources in actual logistics service providers' networks dynamically. These models should also consider how to increase the adoption of automated and zero-emission vehicles/vessels and the use of rail and inland waterways through multimodal solutions.
- Demonstrate tools, technologies and processes to achieve different types of flows compatibility (e.g. through shared standard boxes) and synchro-modal solutions over the logistics service providers' networks, involving shippers and retailers to that purpose.
- Demonstrate the benefit (e.g. GHG reductions vs increased operational costs) of decentralised inventory positions in the pooled logistics network allowing low speed multimodal transport for (re-)positioning stock levels and answering short term lead times with closer to consumer inventory positions (e.g. full visibility of inventory positions in retail networks extended to suppliers and logistics service providers).
- Test and demonstrate sound business and governance models and rules (including organisational change requirements) for resource-sharing across logistics networks, to ensure operational efficiency of freight movements irrespective of mode, nodal operations and freight characteristics.
- Test and demonstrate the functionalities and relevance of the data sharing framework, serving for optimisation of the logistic system, including through the establishment of an appropriate semantic model and its components, such as for instance Digital Twins with specific algorithms allowing for predictive planning of logistic related events. Synergies for rail will need to be sought with the EU-Rail Programme projects implementing the Transversal Topic on Digital enablers and Flagship Area 5³⁵⁴.
- Develop and demonstrate scalability of the proposed solutions providing open access mechanisms and low thresholds to the system of logistics networks. Consider realising visualisation and simulation models and tools to show the practical use of collaborative models for the various types of stakeholders and the potential benefits based on actual cases. Develop specific actions to encourage, facilitate and ensure the access of SMEs and smaller players.
- Measure and demonstrate the benefits in terms of use of resources, affordability of proposed solutions, throughput capacity and environmental impact of the scaled up horizontal collaboration among logistics networks (system of logistics networks).

If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries have to describe if and how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions. In addition, if the activities

³⁵⁴ See EU-Rail Multi Annual Work programme at https://shift2rail.org/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

proposed involve the use and/or development of AI-based systems and/or techniques, the technical and social robustness of the proposed systems is to be described in the proposal.

HORIZON-CL5-2024-D6-01-08: Improved transport infrastructure performance – Innovative digital tools and solutions to monitor and improve the management and operation of transport infrastructure

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 15.00 million.
<i>Type of Action</i>	Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology Readiness Level</i>	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to ALL of the following outcomes (with a clear baseline for each use case):

- Better interconnection of transport infrastructure and transport means resulting in optimised door-to-door mobility for passengers and goods by assuring at least 30% reduction of average delay (time lost per vehicle per km).
- Reduction of transport operation costs by 20% for transport operators along with 20% reduction of fossil fuels consumption in transport.
- Assessment and redesign of existing infrastructure (e.g. cycling lanes, walking paths, charging points, parking spaces etc.) in order to ensure its effective and safe use by different transport modes. Different infrastructure types should be assessed in each of the pilot demonstrations and safe coexistence of various forms of mobility enhanced (e.g. soft, active, shared mobility).
- Increase in the robustness of transport infrastructure by reducing the infrastructure failure probability by 30%.

- Reduce the transport emissions of greenhouse gases and other pollutants by 30% by 2030 in the pilot demonstrations.
- Reduce the number of accidents involving infrastructure users and infrastructure workers by 50% in the pilot demonstrations.

Scope: Innovative digital tools and solutions will allow to upgrade transport infrastructure ensuring an improved performance and safety, together with a reduction of emissions and better inclusiveness. Increasing the performance of multi-modal transport infrastructure can be achieved through improving the efficiency of the assets and by the cross-modal data management. Digital solutions are key to reduce drastically disruptions in traffic flows, increase transport efficiency and lower its dependency on fossil fuels.

Transport infrastructure needs to be capable of harvesting the benefits from digitalisation at management and operations levels, as well as in relation with the user. Digitalisation can support the achievement of sustainability targets and provide a better service to infrastructure end users, including enhanced public transport services. Digital technologies, such as big data, the Internet of Things, Digital Twins, together with Artificial Intelligence and Machine Learning techniques provide a great potential for developing mobility solutions.

The integration between transport infrastructure and digital technologies will help achieve personalised seamless passenger and freight journeys transport across different transport modes. This integration will consider safety and security starting from the design phase, while simultaneously automating and accelerating the decision process at every level from maintenance to traffic management.

Special attention should be given to the accessibility of new digital tools from persons with disabilities and older persons, in order to ensure that this segment of the population is also able to participate fully and benefit from digital progress. As set by the Green Deal, priorities should be given for projects allowing modal shift from road to more sustainable mode such rail and inland waterways.

Proposals will have to address all of the following points:

- Improve performance of transport infrastructure and increase multimodality with the use of, for example: IoT, edge computing and decentralised artificial intelligence, or other digital tools in view of its potential to facilitate real-time decision-making, improve safety and to save bandwidth and energy. Develop solutions for self-monitoring, self-reporting, non-intrusive/non-destructive inspection and testing methods, including advanced predictive modelling and structural safety assessment.
- Demonstrate ability to process internal and external raw data, such as sensor data, into smart data and related cloud architecture that can be deployed to optimize infrastructure management processes
- Building on the common European mobility data space and the Digital Transport and Logistics Forum (DTLF), facilitate the seamless use and provision of data and

information to the end user across the transport infrastructure network and logistic chain, with a view to progress advancing towards smart mobility concepts for passengers and freight.

- Enhance prediction of demand from individual behaviours, enabling appropriate modal capacity and demand management.
- Propose digital solutions contributing to a more inclusive, comfortable, accessible and flexible infrastructures and multi-modal services.
- Include at least three pilot demonstrations of the proposed solutions in operational environment (minimum at TRL7) on land and inland waterways transport infrastructure.
- Evaluate the qualitative and quantitative impact of the proposed measures with a clear baseline for each pilot demonstration.

For rail infrastructure the solutions will need to be harmonised with the EU-RailRAIL Programme projects implementing the Flagship Area 1, 3 and 5³⁵⁵. Proposals should consider results from previous calls on infrastructure maintenance, digitalisation, and on edge-IoT, and focus on validation of innovative solutions (i.e. robotics, IoT, edge computing and AI).

If the activities proposed involve the use and/or development of AI-based systems and/or techniques, the technical and social robustness of the proposed systems is to be described in the proposal.

HORIZON-CL5-2024-D6-01-09: Policies and governance shaping the future transport and mobility systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 3.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

³⁵⁵ See EU-Rail Multi Annual Work programme at https://shift2rail.org/wp-content/uploads/2022/03/EURAIL_MAWP_final.pdf

	additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ³⁵⁶ .

Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- A better understanding of the effects of governance³⁵⁷, policies³⁵⁸, and incentives, but also land use and spatial planning, on the choice of individuals, families, or social groups of different kinds to use a specific transport and/or mobility mode.
- Reinforced public engagement in shaping co-created transport and mobility policies.
- Effective policy interventions, co-created with target constituencies and building on high-quality policy; strengthening of research-policy cooperation models to reinforce impact and trust in science.
- More effective and sustainable national, regional and transnational transport and mobility policies toward accepted approaches, based on a system-thinking perspective.
- Better harnessing the potential of digitised mobility data while protecting citizen’s privacy.
- Providing concepts and policy recommendations sustainably integrating passenger and freight transportation in order to create a future proof holistic mobility system.

Scope: Governance, policies and incentives play an important role in shaping transport and mobility systems and influence the development and implementation of different technologies and modes of transport (e.g. walking, cycling, public transport and rail). It is therefore important to study how policies and regulations could be best used to govern transport and mobility systems in desired directions, so that they become more sustainable and just, for instance with regard to gender, place, or low-income households, as well as their fiscal impacts.

³⁵⁶ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

³⁵⁷ Governance is all the processes of interactions be they through laws, norms, power or language of an organized society over a social system, done by the government of a state.

³⁵⁸ Policies are deliberate systems of guidelines to guide decisions and achieve rational outcomes. Policies are generally adopted by a governance body within a national or local authority.

In addition, the COVID-19 crisis has significantly altered commuting habits; remote and telework have become widespread together with other flexible work arrangements. The true impact of these changes on gas emissions and on the well-being of people as well as on the real-estate market (offices) are not known. This is now an opportunity to leverage on an ongoing change in habits that could result in significant GHG reduction.

Proposals should address all of the following aspects:

- Analyse the influence of politicians on the making of sustainable and non-sustainable transport policies, as well as the impact of their design on accessibility in peripheral areas, identifying synergies with the reform of governance instruments of the European Union (e.g. Trans-European Transport Network, Urban Mobility Framework) to enhance the gradual phase-out policy effect for private car ownership.
- Propose approaches that better integrate mobility policies with policies from other sectors (e.g. energy efficiency, renewables, gender mainstreaming, healthcare, retail and poverty and low income population reduction).
- Consider the benefits of public/private partnerships towards future transport and mobility system, as to secure local adjustment and solutions that are effective and economic for private stakeholders, with a long-term sustainable horizon for the society.
- Identify and assess the potential of (shared) mobility hubs at neighbourhood-level and define the role of organisational innovations in supporting them.
- Explore how small, medium cities and metropolitan areas manage the emergence of micro-mobility and how driverless vehicles are likely to affect urban areas and land use (e.g. mixed use of urban space, dynamic parking).
- Identify the major flaws on national transport and mobility regulations in EU countries and provide recommendations on how to better harmonize them trans-nationally (e.g. incentives for putting bicycles on trains etc.).
- Identify regulations and accountability measures to ensure that mobility data are best utilised for the common good, for example, harnessing the potential of data to stimulate innovation for more sustainable mobility behaviour patterns and guide urban planning, while also protecting citizen privacy.
- Analyse the drivers for public acceptability of stringent and mandatory transport policies (e.g. carbon taxes, urban traffic bans).
- Examine the most effective strategies in promoting the transition to more sustainable freight transport in Europe following the recent and ongoing changes in consumer culture, such as the increase in e-commerce and online.

A 'social optimum' balance should be included to developing research knowledge within new governance models from several perspectives (e.g. socio-economic, environmental, health,

accessibility, gender and inclusion, safety and security aspects). This concept complements the work launched within the Cities Mission regarding MaaR (Mobility as a Right). Synergies with the projects GECKO³⁵⁹, ACCTING³⁶⁰ and SHARED GREEN DEAL³⁶¹ should be explored, given that mobility behaviours and the role of cities as agent of change will influence policy makers in enabling adaptive and anticipatory regulatory schemes and governance with novel policies contributing to sustainable mobility goals.

In addition to the research activities, actions are expected to involve citizens from different backgrounds and origins in the policy analysis to gather and study their understanding, perceptions, opinions and positions, thus contributing to co-designing and co-assessing the most appropriate policies' recommendations. The collection of children's views can also be included in the study. Citizen platforms if existing, can be used for this purpose.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research.

Safety and resilience

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D6-01-10: Ensuring the safety, resilience and security of waterborne digital systems

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 8.50 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Technology</i>	Activities are expected to achieve TRL 5-6 by the end of the project –

³⁵⁹ <https://h2020-gecko.eu/>

³⁶⁰ <https://www.esf.org/eu-projects/accting/>

³⁶¹ <https://mailchi.mp/06ac151106cf/shared-green-deal>

<i>Readiness Level</i>	see General Annex B.
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Expected Outcome: Project outputs and results are expected to contribute to the following expected outcomes:

- Increased safety and resilience of waterborne digital systems, including system of systems and their functions and considering both malicious intervention and system failure with particular regard to the application of artificial intelligence methodologies, networks of sensors and the onshore on-board communications.
- Improved system design addressing human factors issues in the changing levels of human/automated system interactions
- Assurance of the resilience, safety and security of waterborne digital and connected systems is undertaken on the basis of robust methodologies to a similar standard to that applied within other sectors which apply safety critical digital technology and their application in safety critical conditions including the safety of navigation and its systems.
- Robust by design waterborne digital and connected systems for safety and resilience (incl. reliability regimes such as fail safe, fail secure, fail to operation etc., HAZOP, system of systems, security, hardware and equipment data, etc.)
- Methodologies to enable effective HAZOP analysis and validation of waterborne digital systems are developed and disseminated, increasing the use of common approaches, also when using artificial intelligence applications.
- Increased software safety (incl. functional analysis and reliability assessment).
- Increased cyber security for operation and maintenance (incl. software maintenance).

Scope: Increasingly, modern waterborne transport relies upon smart digital and connected systems to ensure safe and efficient operation. Within large complex vessels, system of systems approaches are used together with Internet of Things and Artificial Intelligence approaches to integrate diverse systems ranging from sensors, business and cargo management systems, power and engine management, electronic navigation and situational awareness. System integration of systems with proprietary digital control systems has become more and more critical in terms of ensuring safety and efficiency. The complexity and foundation upon software, makes assurance of the resilience of such systems challenging and requires a different to that applied to hardware- based systems. Waterborne digital system can be vulnerable to both malicious intervention and the consequences of system failure. Examples have included the spoofing of navigational GPS signals, ransom wear attacks on integrated container management systems, complete power shutdown and the helicopter evacuation of a large passenger ship when engine protection systems identified a common fault across all engine waterborne systems. The challenge to assure the safety and resilience of digital systems is particularly important within large complex vessels where the level of

integration and connectivity is high and where the consequences of failure can be particularly severe.

In the domain of power generation and management the vastness of new technological solutions, often driven by environmental regulations, poses new challenges in ships' design and management, where the need for integration of diverse energy converters (ICEs, batteries, fuel cells, wind, capacitors, etc.) confront designers and operators with systems based on profoundly different operating principles coming together with different requirements and control and digital systems. Integration for harnessing the full potential in a safe and secure frame is key to their implementation.

Furthermore, the capability of integrating different systems (and their dynamics) involve an always increased number of sensors, whose data, fused, should become available for optimisation and increased awareness during normal and safe critical operations.

Comprehensive HAZOP (Hazard Operability) studies are essential for such vessels, yet the methodologies are poorly established within the waterborne sector whilst other sectors operating safety critical digital systems (aerospace, nuclear, medical automotive etc.) have well established practices. Furthermore, applying "hardware in the loop" to simulation and validation of digital systems is dependent on the quality of the digital simulation model. This can be difficult for waterborne transport due to the variability of ship designs, complexity and lack of relevant data concerning the integrated components. Pre-delivery testing and sea trials could include fault simulation and digital testing founded upon the identification of critical digital systems identified by the HAZOP, yet such trials focus on hardware or subsystems such as rudder control rather than addressing the entire integration. For safety critical systems, reliability regimes need to be established to identify the safe default state in case of system failure or the identification of malicious intervention. In this respect the best system state could be: "fail operational", "fail soft", "fail safe", "fail secure", "fail passive", "be fault tolerant".

Activities will address the development of a HAZOP methodology for whole system assessment of highly digitised, connected complex vessels. The methodology should include system, system of systems designed for specific function or sets of functions and/or a methodology for the entire vessel, including when application of artificial intelligence algorithms is foreseen. The methodology will be developed with relevant stakeholders including shipbuilders, system designers and equipment providers, IT professionals, operators, class societies, regulators. The acceptability of the methodology to all stakeholders will be assessed and an implementation roadmap will be developed to account for any identified barriers. Work will draw upon the expertise of other sectors with more developed procedures for the assessment and assurance of digital safety.

On-board systems and functions integration by design, for safe and secure operation should be used to test and demonstrate the safety and security of the applications.

The developed methodology will be applied to a representative complex highly digitised vessel, safety critical systems and functions will be identified, and appropriate reliability

regimes and mitigation measures will be established with consideration of both malicious intervention and system failure.

Cost effective methodologies for validating the safety, resilience and correct functioning of digital and connected safety critical ship systems, including system of systems, will be developed and demonstrated.

- In case of validation on the basis of a theoretical digital models and/or digital twinning (e.g. hardware in the loop) then the validity of the model should be proven as well as its flexibility to be applied towards a range of vessel designs.
- In case of validation on the basis of physical testing of the responses of the final system to a range of fault conditions and malicious interventions during the final trials, there should be assurance that test conditions are representative of the identified risks.

Guidance should be produced and disseminated concerning the recommended methodology for assuring the safety and resilience of complex digitalised and connected shipping.

The safety assessment should be developed by using methodologies suitable for being assessed in international fora such as the International Maritime Organisation.

HORIZON-CL5-2024-D6-01-11: Effects of disruptive changes in transport: towards resilient, safe and energy efficient mobility

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of between EUR 3.00 and 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 7.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for

	Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ³⁶² .
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Expected Outcome: Research is expected to contribute to all the following outcomes:

- Transport systems that are resilient, i.e. prepared for disruptive changes of different kinds, and thereby supporting continuously improved traffic safety.
- Resilience to unexpected events (pandemics, natural disasters, political decisions, conflicts, energy and fuel disruptions, raw materials and component supply vulnerabilities etc.) as an integrated principle in the design and development of future transport systems.
- Increased understanding how sudden changes in the availability of transport means e.g. through dramatic weather events or emission induced ban of certain vehicles in a city, affect the safety of transport system users, and the underlying psychological effects for users' reactions.

Scope: The importance of a robust transport systems becomes highly evident in times of rapid, changes that are neither planned, scheduled nor predicted. The COVID-19 pandemic has pointed at several issues (e.g. delivery of essential goods, ensuring uninterrupted and safe public transport operations for essential workers etc.) that need to be addressed to secure future resilience of the transport system and to ensure that the level of transport safety is not only maintained, but also meeting more demanding targets. For instance, the decreased use of public transport during the pandemic has to some extent led to increases in both biking and walking, but also an increased use of cars in some parts of the world. At the same time, decreased traveling has meant fewer vehicles on the roads in certain areas, whereas others have seen an increase of delivery vehicles, as home deliveries have surged. Likewise, the current energy market realities have made even more pressing the need of an energy efficient mobility system that could absorb disruptions in the fuel supply chain.

Digital tools/services and new transport means (e.g. urban air mobility and micro mobility), new ways how to use the infrastructure (e.g. even more shared spaces with different types of vehicles, both highly automated and manually controlled) in a more energy efficient manner and new behaviour should be included in the research.

In order to provide safe and resilient transport for all, many aspects are expected to be considered in a clearly multidisciplinary approach. Proposed actions are expected to address at least three out of the following aspects:

³⁶² This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Scenarios of disruptive changes that can make a transport system unstable should be identified, the consequences on transport safety be analysed, and solutions to tackle them developed. This includes safety implications of rapid changes / new incentives (sometimes contradictory to previous ones, e.g. regarding the use of public transport in a pandemic situation).
- Analysis of how socio-economic differences may affect the safety of individuals in case of disruptive changes (e.g. individual mobility options are determined by the socio-economic status).
- Study of how the concept of resilience at the system level can be applied and used for the improvement of transport safety.
- Evaluation of the potential and development of recommendations on how to improve transport safety and resilience through suburban planning and future housing developments with their effects on the demand for transport and through the design of transport infrastructure networks.

A definition of resilience in the context of transport systems should be provided, and factors of transport safety and energy efficiency that are essential to take into account should be determined. Moreover, scenarios for disruptive changes should be identified that can make a transport system instable, the consequences on transport safety be analysed, and solutions to tackle them be developed. Hence, a structured method to secure safety as an integrated part in resilient transport systems should be provided.

A solid foundation for this research is the Safe System Approach. It requires the inclusion of relevant expertise in social sciences and humanities (SSH) and will benefit from international cooperation.

HORIZON-CL5-2024-D6-01-12: A new framework to improve traffic safety culture in the EU

Specific conditions	
<i>Expected EU contribution per project</i>	The Commission estimates that an EU contribution of around EUR 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR 7.00 million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). ³⁶³ .

Expected Outcome: Research results are expected to contribute to all the following outcomes:

- Growing a positive traffic safety culture across the EU that supports the Vision Zero goal and the Safe System Approach, and which is in line with the UN Sustainable Development Goals and the 2020 Stockholm Declaration, UN General Assembly Resolution and Global Plan of Action for the second decade on road safety
- Remedial action against detrimental, non-temporary impacts of the COVID-19 pandemic on certain road safety risk factors such as a shift from collective to individual means of transport. Facilitation of a shift to increase efficiency in road safety related public spending across Europe together with a shift towards more energy efficient mobility choices.
- Development and evaluation of strategies to transform the traffic safety culture of road users and stakeholders based on a valid model that identifies the key components defining traffic safety culture, including, for example, social norms, attitudes, perceived control, values, and system assumptions (including its energy efficiency and consumption)
- Concepts and guidelines to make the concept of traffic safety culture an integral part of road safety work of actors across the socio-economic systems of European societies
- Better understanding of the link between road safety outcomes and safety culture; pilot implementation of road safety education at secondary school level and also for decision makers and practitioners in EU Member States/Associated countries.

Scope: A Safe System entails the understanding and managing of all elements of the transport system, including the behaviour and interplay of its actors. Comparative analysis shows persistent differences in road safety performances between EU Member States/Associated countries. These differences may be attributable to differences in culture, which are hard to

³⁶³ This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

explain with classical risk models. Efforts should therefore be made to complement road safety initiatives by a *safety culture* perspective, i.e., the values, beliefs, priorities and viewpoints shared among groups of road users and stakeholders that influence their decisions to behave or act in ways that affect safety, while also considering energy consumption. This concept is already well established in organisational research.

Assessing road safety cultures in different national, regional or local systems, groups and organisations is believed to help understanding and explaining different patterns of risk perception and risk taking across communities and countries – and can likewise inform tailored interventions for these (sub-)cultures, which all come with their specific norms, values, beliefs and behaviours (including gender-related behavioural patterns). These interventions should address all relevant actors in the system for road transport of people and goods, and consider future developments, such as potential impacts by increasing automation levels or by the introduction of new means of road transport such as e-scooters and hoverboards.

Within this context, actions should contribute to establishing a framework for cultural transformation in road safety across the EU and thereby address all the following aspects:

- Better understanding of the link between road safety outcomes and safety culture, i.e. of sociocultural factors like values, beliefs, attitudes, and norms and their effects on actual behaviour of road users (including subjective perception of safety as well as implications of value of time and institutionalised travel costs) – and the ways how these factors can be sustainably transformed.
- Consideration in particular - but not exclusively - of traffic behaviour with high safety impacts, such as inadequate speed choice, distraction by communication or control devices, driving or riding under the influence of alcohol or drugs, non-use of protective devices, and risks triggered by professional drivers' requirements to multitask and report while driving.
- Assessment of safety cultures and respective activities from other transport modes such as aviation and rail and their potential for road safety.
- Assessment of the interplay between shifting to more energy efficient mobility solutions and traffic safety.
- Consideration of safety impacts of new technologies (including better understanding and use of Advanced Driver Assistance Systems (ADAS)) and emerging transport means and services.
- Consideration of the safety impact of the increasing penetration of urban micro-mobility systems in mixed traffic scenarios and evaluation of potential safety improvements for the protection of micro-mobility users.

- Stocktaking of good practices from countries and companies worldwide already successfully applying cultural approaches to (road) safety work, including countries outside of the EU such as the US and Australia.
- Targeting all levels of the socio-economic systems of societies in the EU, i.e. from European to national, regional and local communities, including entities such as schools and workplaces. Also, NGOs, victims' organisations etc. can play an important role in that regard.
- Clear guidance & hands-on advice on the design and evaluation of interventions to define, measure, transform and institutionalise traffic safety culture across all areas affecting road safety – for decision-makers and practitioners, with a good geographic coverage across EU institutions, EU Member States/Associated countries. At the level of individual road users, including VRUs, such interventions may entail targeted educational and communication efforts to challenge wrong beliefs or to clarify misperceived social norms, and the use of incentives and nudging to encourage compliant behaviour. At the level of enterprises and authorities, initiatives may include the take-up of safety culture principles in sustainability reporting and encompass various activities from staff training and supervision to procurement and operations – at best permeating work culture and norms of an organisation. Advice at the level of EU Member States/Associated countries and the EU is sought on how to support such transformation such as with legislation, enforcement, and data.
- At least three different pilot tests of selected interventions at various levels in different EU Member States/Associated countries.

Actions should be based on the results of previous research projects in this domain, such as the TraSaCu project, and make advances by completing and updating their theoretical foundations, teaming up with EU stakeholders and bringing their findings to life by establishing a framework for true cultural transformation in road safety both among stakeholders and road users. Making use of data that is already being collected in EU Member States/Associated countries about traffic safety culture such as the ESRA initiative (which already involves 60 countries, including over 20 European ones) and Baseline³⁶⁴ project is strongly encouraged.

Special attention should be given to EU countries with lower safety performance³⁶⁵. Integration of relevant expertise from social sciences and humanities (SSH) and international cooperation with partners from the US and/or Australia is encouraged.

³⁶⁴ <https://www.baseline.vias.be/en/>

³⁶⁵ According to the data provided by the European Road Safety Observatory (https://ec.europa.eu/transport/road_safety/statistics-and-analysis/data-and-analysis/facts-and-figures_en)

Other Actions³⁶⁶

Grants to identified beneficiaries

1. Support for the SET Plan Conference in 2023 (Presidency event)

Spain will organise the annual Strategic Energy Technology Plan conference in 2023. The conference will take place in Spain during the Spanish Presidency of the Council of the European Union. The European Commission will support the organisation of the annual SET Plan conference in cooperation with the entity designated by the Spanish Presidency.

This grant will be awarded without a call for proposals according to Article 195(e) of the Financial Regulation and Article 24(3)(b) of the Horizon Europe Regulation to the legal entity identified below as the co-organisation of SET Plan Conference falls under its competence.

Due to political sensitivity of the event, the evaluation committee will be composed fully by representatives of EU institutions.

Subcontracting is not restricted to a limited part of the action.

Legal entities:

FUNDACION ESPAÑOLA PARA LA CIENCIA Y LA TECNOLOGIA, F.S.P. (FECYT),
C/ Pintor Murillo, 15, 28100 Alcobendas – Madrid, Spain

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: 4th quarter of 2023

Indicative budget: EUR 0.25 million from the 2023 budget

2. Support for the SET Plan Conference in 2024 (Presidency event)

Hungary will organise the annual Strategic Energy Technology Plan conference in 2024. The conference will take place in Hungary during the Hungarian Presidency of the Council of the European Union. The European Commission will support the organisation of the annual SET Plan conference in cooperation with the entity designated by the Hungarian Presidency.

³⁶⁶ The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

This grant will be awarded without a call for proposals according to Article 195(e) of the Financial Regulation and Article 24(3)(b) of the Horizon Europe Regulation to the legal entity identified below as it is responsible for energy policy and will lead all activities on energy policies during the time of Hungarian Presidency of the Council of the European Union. As such, the co-organisation of SET Plan Conference falls under its competence.

Due to political sensitivity of the event, the evaluation committee will be composed fully by representatives of EU institutions.

Subcontracting is not restricted to a limited part of the action.

Legal entities:

Ministry of Energy, 1011 Budapest, Fő utca 44-50; Hungary

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: 4th quarter of 2024

Indicative budget: EUR 0.25 million from the 2024 budget

3. ENTSO-E and the EU.DSO Entity cooperation in the realisation of a Digital Twin of the EU Electricity Grid

In the framework of the Digitalisation of Energy Action Plan, the Call D4-2-8 will contribute to the development of a Digital Twin of the EU Electricity Grid to improve management, operations and resilience of the EU Electricity System in support to REPowerEU.

In addition, coordination and support from both the EU.DSO Entity and ENTSO-E are key to ensure that bottom-up smart grid and digital investments of TSOs and DSOs are interoperable and build on best-practices, at EU-level, to promote seamless data exchange between TSOs and DSOs on the one hand, and TSOs-DSOs with the market on the other hand. The aim is to facilitate EU-wide markets for innovative data-driven services, for example in demand response, integration of renewables, and smart charging of electric vehicles.

ENTSO-E and EU.DSO cooperation will also target the following outcomes:

- i. Strengthened observability and controllability of the grid
- ii. Optimised infrastructure and network planning

- iii. Joint modelling for a more resilient grid in terms of RES integration and cybersecurity (e.g. in the framework of the TYNDP and EERA)
- iv. Increased use of active System Management and Forecasting to support Flexibility and Demand Response

This grant will be awarded without a call for proposals according to Article 195(e) of the Financial Regulation and Article 24(3)(b) of the Horizon Europe Regulation.

The evaluation committee will be composed fully by representatives of EU institutions.

Legal entities:

European Network of Transmission System Operators for Electricity (ENTSO-E), Rue de Spa 8, B-1000 Brussels, Belgium

European Distribution System Operators Entity (EU DSO Entity), Avenue de Tervueren 188A / Box 4, 1150 Sint-Pieters-Woluwe (Brussels), Belgium

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: 2nd quarter 2023

Indicative budget: EUR 1.50 million from the 2023 budget

Public procurements

1. Study on how to mobilize industrial capacity building for advanced biofuels

Based on the assessment of the industrial capacity needs and potential of the WP 2021 tender study³⁶⁷ and the roadmap for building it, this study will identify and propose ways to realize the industrial value chains, including financial, technical, business and feedstock related.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter 2023

Indicative budget: EUR 0.50 million from the 2023 budget

³⁶⁷ <https://ted.europa.eu/udl?uri=TED:NOTICE:219917-2022:TEXT:EN:HTML>

2. Technical support for low carbon and renewables policy development and implementation

This action aims at providing technical support for the development and implementation of policies related to low carbon and renewable energy. The main base will be the recast of the renewables directive 2018/2001, as well as preparatory actions linked to the European Commission proposals for the amended renewable directive 2021/0218 (COD) and the hydrogen & decarbonised gas market package 2021/0423 (COD), 2021/0424 (COD), and 2021/0425 (COD).

This would include studies on sustainability, certification, climate impacts, industry competitiveness, consumer information, and facilitation of standardisation. Furthermore, communication activities that enable stakeholder engagement can be undertaken.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 1st quarter and 3rd quarter of 2023; 1st quarter and 3rd quarter of 2024

Indicative budget: EUR 1.00 million from the 2023 budget and EUR 1.00 million from the 2024 budget

3. Support to the development, implementation, monitoring and evaluation of climate, energy and mobility research and innovation policy activities

The action focusses on three types of activities:

- Technical assistance, and economic and policy analysis to support various aspects of the research and innovation policy relevant in climate, energy and mobility and related sectors.
- Communication activities, such as events and publications, that could support dissemination of knowledge and information to interested organisations and individuals, as well as development of new forms of cooperation and information exchange between interested organisations and individuals.
- Providing information on new forms of innovation in the climate, energy and mobility sectors, as well as new forms of supporting innovation, e.g. start-up support, new business models, new financing instruments, cooperation with organisations outside the climate, energy and mobility sectors, supporting innovation investment communities and intermediaries.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: as of 1st quarter 2023 and as of 1st quarter 2024

Indicative budget: EUR 1.50 million from the 2023 budget and EUR 1.50 million from the 2024 budget

4. Extension of the METIS energy model in terms of market design, demand sector granularity and interface with regions outside of Europe

METIS is a mathematical model providing analysis of the European energy system for electricity, gas and heat. It simulates the operation of energy systems and markets on an hourly basis over a year, while also factoring in uncertainties like weather variations. The model also explicitly represents electricity transmission and distribution networks. The addition of hydrogen as an energy carrier have allowed using the model in the Impact Assessment for revised gas markets and hydrogen directive and regulation. Further ongoing developments address the better integration of demand with supply sectors and a finer regional granularity.

In order to secure the model in future policy cycles, extensions would be necessary along the following three dimensions:

1. A representation of energy markets including the behaviour of buyers and sellers.
2. The inclusion of all demand sectors including a linkage of demand in these sectors to economic activity as represented by macro-economic models.
3. The interaction with energy systems outside the EU that have a key impact on the EU energy system, e.g. via exports of electricity, gas and hydrogen.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter of 2023

Indicative budget: EUR 2.50 million from the 2023 budget

5. Development of standardisation methods for eco-design and energy labelling of photovoltaic products

This action aims at developing standardised (pre-normative) methods relevant to eco-design and energy labelling of photovoltaics. In particular, there would be two sets of methods developed:

- Standardised method for the calculation and testing of the yield of bifacial photovoltaic modules and;
- Standardised method for the measurement and testing of the long term degradation of the photovoltaic modules performance (some activity started with the preparation of the IEC 63209 standard). The main aspects of interest (e.g. thermal fatigue, damp heat, etc.) should be identified.

The research should cover at least:

- Characterization (e.g. insulation test, wet leakage current test) and stabilization techniques to be applied;
- Procedure for the collection of testing samples;
- Definition of the testing protocols, testing sequence and, when applicable, pass criteria, related to the various aspects of interest (e.g. thermal fatigue, damp heat, etc.).

The overall duration of the testing process should also be analysed, with the aim of minimising it, while keeping a minimum defined level of confidence in the results. This may also imply the calculation and development of correlation factors on the basis of the duration of the testing process.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 0.60 million from the 2023 budget

6. Development of a recyclability index for photovoltaic products

This action aims at developing a recyclability index for photovoltaic modules, to be built up starting from the general methods laid down in the horizontal standards developed under M/543 and under eco-design and energy labelling regulatory framework.

The research should cover at least:

1. Analysis of the recycling processes currently available and expected to become available in the short-middle term for photovoltaic modules;
2. Identification of CRM (critical raw materials) and environmentally relevant materials present in the bill of materials of the photovoltaic module technologies currently available and expected to become available in the short to medium term;
3. Analysis of the various design solutions/architectures for photovoltaic module technologies currently available and expected to become available in the short to medium term.
4. Development, calibration and validation of a scoring methodology taking into account the abovementioned topics, e.g. by including the identification of:
 - a. Priority parts (to the extent of material relevance – CRM/environmentally relevant material – and material recyclability);
 - b. Key parameters for repair and upgrade;

c. Scoring framework.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 0.30 million from the 2023 budget

7. Comprehensive study on the internalisation of external costs in transport

The action foresees the continuation and update of previous works on the internalisation of external costs in transport, in line with the EU's Sustainable and Smart Mobility Strategy. This includes an update of the respective handbook on the external costs of transport, which is widely and intensely used as source of information, both for the European Commission's analyses, studies and impact assessments, as well as by other stakeholders around the world (including researchers, NGOs and Member States themselves). The previous study³⁶⁸ was published in 2019 and new data would become available by 2025, thus this action will allow to mirror the frequency of updates of the handbook over the past decades.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 1.00 million from the 2023 budget

8. Support to R&I strategic planning and implementation with regard to smart energy systems, ensuring feedback from R&I projects and communities to policy-making processes

The action is directly aimed at supporting the development and implementation of sound evidence base for R&I policies in the field of smart energy systems, encompassing all energy vectors and including storage. Energy system integration, digitalisation and power grid flexibility are important themes. The action will support the coordination of stakeholder views on R&I strategy by using existing structures (including the BRIDGE initiative and the ETIP Smart Networks for the Energy Transition) and possible new initiatives (if applicable), and by building on the Strategic Energy Technology Plan approach and developments. It will also mobilise inputs and feedback coming from the R&I communities and EU-funded projects and provide advice and feedback to EU policy-making processes supporting the rollout of policy instruments.

Form of Funding: Procurement

³⁶⁸ https://transport.ec.europa.eu/transport-themes/sustainable-transport/internalisation-transport-external-costs_en

Type of Action: Public procurement

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 3.00 million from the 2023 budget

9. Study on the macro-economic impacts of the climate transition

The study will carry out in-depth analytical work to assess the socio-economic impacts of the transition to climate neutral economies. It will focus on issues that have been insufficiently explored thus far, including risks related to frictions in the reallocation of labour and capital across economic sectors, the political economy of the transition process, distributional issues, the impacts of stranded assets and the implications of the transition for government finances. The study will rely at least in part on macro-economic modelling tools.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter 2023

Indicative budget: EUR 2.00 million from the 2023 budget

10. Dissemination and information activities

Communication activities such as meetings, conferences, out-reach communication events/papers/materials and publications should support dissemination of knowledge and information to relevant stakeholders.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: as of 1st quarter in 2023 and as of 1st quarter in 2024

Indicative budget: EUR 1.60 million from the 2023 budget and EUR 0.70 million from the 2024 budget

11. Support to the revised SET Plan

The Strategic Energy Technology Plan will be revised in Spring 2023 to better support the European Green Deal objectives, make the SET Plan fully compatible with the ‘fit for 55’ proposals, the 2050 decarbonisation goal and the REPowerEU initiative, while ensuring continued support to long-term research on new energy sources.

To facilitate the implementation of the revised SET Plan, this action should support the following activities:

- Communication activities (including a revamped SET Plan website);

- Support to cross-cutting activities crossing thematic Implementation Working Groups;
- Capacity building activities and assistance to SET plan countries, in particular newcomers;
- Support in managing unexpected policy/technology developments.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter 2023

Indicative budget: EUR 1.00 million from the 2023 budget

12. Support action on heat pumps

The REpowerEU Plan has set ambitious objectives for heat pump deployment in Europe. The Commission report on the Competitiveness of clean energy technologies of 15 November 2022 indicates some bottlenecks that are also related to scaling up manufacturing and to improve certain technical aspects (e.g. smart controls of heat pumps or faster transition to low-GWP refrigerants). The aim of this action is to take stock of the results of R&I projects on heat pumps in both the building and industry sectors, monitor data on deployment (including existing and potential workforce and/or skills shortages) and competitiveness of heat pumps, consult the key heat pump industrial and research actors in the EU in order to develop a joint research approach for low upfront-cost, efficient, smart and interoperable heat pumps (including for existing buildings where heat pumps are currently not an affordable option), as well as supporting a specific activity strand in the frame of the SET Plan.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter 2023

Indicative budget: EUR 0.50 million from the 2023 budget

Subscription actions

1. Contribution to Technology Collaboration Programmes (TCPs) of the International Energy Agency (IEA)

The Commission represents the European Union in the Technology Collaboration Programmes (TCPs) concluded under the framework of the International Energy Agency where it participates in activities in certain areas of energy research. The annual financial contributions will be paid to the entities responsible for managing the following TCPs:

- Geothermal Energy Research and Technology;

- Bioenergy;
- Ocean Energy Systems;
- International Smart Grids Action Network (ISGAN);
- Greenhouse Gas Research & Development;
- Solar Power and Chemical Energy Systems;
- Photovoltaic Power Systems;
- Solar Heating and Cooling;
- Hydrogen;
- Wind Energy Systems;
- Gas and Oil Technologies;
- Energy Efficient End-Use Equipment;
- Equality in Energy Transitions.

Type of Action: Subscription action

Indicative timetable: as of 1st quarter 2023, as of 1st quarter 2024

Indicative budget: EUR 0.45 million from the 2023 budget and EUR 0.45 million from the 2024 budget

2. Subscription of the EU to the Intergovernmental Panel on Climate Change (IPCC)

The European Union is an observer of the Intergovernmental Panel on Climate Change (IPCC), the most authoritative source of knowledge about climate change. The IPCC policy on observers recognises the special status of the European Union and gives Commission representatives the right to speak and to introduce proposals like any IPCC Member, but not to vote. The IPCC puts no financial obligations on members and observers but funded solely through voluntary contributions and grants. The EU has been a significant contributor to the IPCC including, most recently, through a grant under the call H2020-IBA-SC5-IPCC-2019 aimed to facilitate the preparation of the IPCC's its Sixth Assessment Report (AR6). The IPCC is now completing its Sixth Assessment cycle and the mentioned grant expires in 2024. Given IPCC's importance in promoting science-based approaches in climate action, it would be appropriate to continue supporting the IPCC Panel at the current rate, in the form of a subscription as a token of EU's commitment to evidence-based policies.

Type of Action: Subscription action

Indicative timetable: 4th quarter 2024

Indicative budget: EUR 0.63 million from the 2024 budget

3. Contribution to the International Renewable Energy Agency (IRENA)

The European Union is a member of IRENA. According to the organisation's Statute and Financial Regulation this implies the obligation to pay an annual contribution to its budget covering the participation of the EU in IRENA's activities. IRENA's main objective is to disseminate best practices in the field of renewables as the principal platform for international cooperation in the field, a centre of excellence on renewable energy and a repository of policy, technology, resource and financial knowledge. This includes:

- The promotion of the widespread and increased adoption and the sustainable use of all forms of renewable energy globally, including in the EU, in particular to bring down costs and also to increase market experience, in order to contribute to economic growth and social cohesion as well as access to and security of energy supply;
- Support activities for countries in their transition to a renewable energy future;
- Reducing of barriers for renewable energy, stimulating best practice and raising awareness.

Type of Action: Subscription action

Indicative timetable: 1st quarter 2023, and 1st quarter 2024

Indicative budget: EUR 0.56 million from the 2023 budget and EUR 0.56 million from the 2024 budget

4. Voluntary contribution to participation in workstreams of the Clean Energy Ministerial

The Commission has been active in the Clean Energy Ministerial (CEM) since its inception in 2010 and the European Union formally became a member on 6 June 2016 when the EU Energy Ministers formally endorsed the CEM Framework. The CEM consists of major economies that, together with the European Commission on behalf of the EU, are aiming to accelerate the global clean energy transition. Together they have the potential for making a major impact as they represent about 90% of global clean energy investment and 75% of global greenhouse gas emissions. The Commission supported the extension and strengthening of CEM's mandate to Phase III, or CEM3.0 (from July 2022 to June 2025) and provided voluntary contribution for its Secretariat.

Under CEM, groups of member countries create, engage in and provide voluntary financial contributions for CEM workstreams (initiatives and campaigns) to advance specific CEM objectives. The Commission currently co-leads and supports financially the operating agents of the following initiatives: the Super-efficient Equipment and Appliance Deployment (SEAD) initiative (50.000 EUR/year) and the Hydrogen initiative (20.000 EUR/year).

Type of Action: Subscription action

Indicative timetable: 2nd or 3rd quarter 2023 and 2nd or 3rd quarter 2024

Indicative budget: EUR 0.07 million from the 2023 budget and EUR 0.07 million from the 2024 budget

5. Contribution to the International Energy Agency (IEA) – Energy Efficiency Hub (EE HUB)

The purpose of the International Partnership for Energy Efficiency Cooperation (IPEEC) is to strengthen international cooperation on energy efficiency. The action carried out under the auspices of the partnership should result in more effective energy policy and programme output, in best practices being more widely known, disseminated and applied and in economies of scale. The aim of the partnership is to offer a topic-driven, structured dialogue and an operational network for enhanced cooperation and exchanges on energy efficiency between countries and international organisations by:

- exchanging information and experience on development of regulatory measures, policies and programmes;
- developing benchmarks and sharing information on goods and services, along with measurement methods regarding energy performance and energy savings;
- strengthening information, education and training for energy consumers;
- building stakeholder capacity by improving contacts between national, regional and local authorities and other relevant partners and stakeholders, exchanging views and sharing knowledge and experience.

Type of Action: Subscription action

Indicative timetable: 1st quarter 2023, 1st quarter 2024

Indicative budget: EUR 0.08 million from the 2023 budget and EUR 0.08 million from the 2024 budget

Scientific and technical services by the Joint Research Centre

1. Continuation of the Transport Research and Innovation Monitoring and Information System

TRIMIS was announced by the Commission's "Europe on the Move" Communication in May 2017, as an important instrument for assessing technology trends and research and innovation capacities in the transport sector. Since its launch in September 2017, it has been serving as a one-stop-shop that gathers, analyses and provides open-access information on transport research and innovation activities at EU and Member State level. TRIMIS is providing up to date, reliable information and analyses in support of the research community, transport stakeholders and policy makers, facilitating exchanges between partners and informing decision making processes. It is also acting as a monitoring system of progress against agreed

targets and roadmaps, notably towards the delivery of the European Green Deal, EU's Sustainable and Smart Mobility Strategy and Fit for 55 targets.

The current operating horizon of TRIMIS is until 2024 and this action will enable its continuation beyond that timeframe. In particular, it will allow to capture in the database and analyses of TRIMIS the results of EU-funded and Member States' projects available after 2024 (including from the Horizon 2020 Green Deal Call). Furthermore, this action will enable to expand the work of TRIMIS, developing new analyses, technology assessments and recommendations for future Research & Innovation and policy action. Finally, the extension of TRIMIS will allow the continuous monitoring of strategic transport research and innovation agendas, with Key Performance Indicators to track progress against targets, as well as reporting on the progress of innovation and implementation, following the funding support provided by Horizon Europe and other programmes.

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: 2nd quarter of 2024 for the service level agreement

Indicative budget: EUR 2.00 million from the 2024 budget

2. Upgrading of the TENtec alternative fuels infrastructure analyses to support research and policy

Regular and reliable information on the progression from research to deployment is necessary for further research, evidence-based policy and decision making. In particular, information on alternative fuels infrastructure deployment and identified gaps in the network can help direct public funding (e.g. Horizon Europe, CEF) where it is most needed, to support the uptake of innovative solutions for sustainable transport. Better visibility of the alternative fuels network can also facilitate investments in research and innovation by private stakeholders. Valuable information is starting to become available, for instance through the European Alternative Fuels Observatory³⁶⁹ and the first analyses performed in TENtec. However, additional data and analyses are needed to develop a comprehensive algorithm that takes account of routing, to perform an in-depth, comprehensive assessment of alternative fuels network coverage on the TEN-T network. The development and integration of new thematic data layers in TEN-T will also foster new analyses and research into the opportunities and effects of EU policies on alternative fuels.

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: 1st quarter of 2023 for the service level agreement

Indicative budget: EUR 0.20 million from the 2023 budget

³⁶⁹ <https://www.eafo.eu/>

3. Support for the design and implementation of cost-effective solutions for zero-emission HDVs

This action aims at providing scientific and technical support from the JRC to EU policies on Heavy Duty Vehicles (HDV) CO₂ emissions for the decarbonisation of the EU transport system. Activities will be coordinated with the European industrial players (e.g. Hydrogen and Batteries' partnerships, components and auxiliary industry), research and standardization stakeholders.

Duration: 24 months

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 1.50 million from the 2023 budget

4. European Storage Inventory

With the REPowerEU Plan and its ambition to accelerate the uptake of renewable energies, energy storage has become ever more important to guarantee energy supply security. In this context, it is important to trace its technological development and deployment across the EU, in order to inform energy policymaking, R&I programming, and the revised SET Plan. This action will aim at setting up a European Storage Inventory that surveys and maps energy storage R&I (including pilot sites), as well as major commercial installations through interactive IT tools and data bases. It will feed into the work of the Clean Energy Technology Observatory in highlighting major developments in storage R&I, observed trends and their assessment, as well as an assessment of the annual deployment of storage and total cumulative storage stock across the EU. The latter will be important for energy modelling and security of supply assessments. The European Storage Inventory is expected to develop synergies with the Clean Energy Technology Observatory.

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: 1st quarter 2023

Indicative budget: EUR 1.00 million from the 2023 budget

Indirectly managed actions

1. Contribution to InvestEU blending operation under the Green Transition product

The 'Fit for 55' package of measures adopted by the Commission in July 2021 sets out the policies and legislation for the EU to meet its 2030 target of 55% net greenhouse gas emissions reductions, which will create new opportunities for investment in new technologies

and approaches. The final aim is decarbonising the economy in line with the objectives of the Paris Agreement, the European Green Deal and the European Union's 2050 net-zero target, and Climate Law. That is why the European Commission intends to establish an efficient framework to identify European projects deploying innovative technologies, business models and approaches to reduce the green premium – the difference between the price of a carbon-emitting technology and its clean alternative. Under existing initiatives, the Commission has already been supporting, under InnovFin and other EU programmes, a variety of technological pathways for decarbonisation. InnovFin Energy Demonstration Projects³⁷⁰, in particular, has been very effective at mobilising finance for first-of-a-kind projects in the area of innovative renewable energy production, storage and smart grids. It has mobilised so far EUR 346 million of EU support for 11 operations (with total project costs of EUR 864 million).

The blending operation will target projects at TRLs 6-8 via the European Investment Bank (EIB) or other implementing partners' financial instruments, by providing loans and quasi-equity (or a combination of both), which may be blended with non-reimbursable components. The financial instrument component of operations may draw from the Innovation Fund, this Horizon Europe action, or the InvestEU budget, while the non-reimbursable component will only be funded by this Horizon Europe action – to be spent economically as a last resort option to enable project's financial closure.

The blending under the InvestEU's Green Transition product focusses on the following four areas that are underrepresented in the current portfolio of InnovFin:

- *Renewable hydrogen.* In July 2020, the Commission adopted the Hydrogen Strategy³⁷¹ with the aim of decarbonising its production and to expand its use to store, transport and accelerate the use of renewable energy, as well as replacing fossil fuels in specific sectors, aiming to reach 40 GW of electrolyser capacity by 2030, producing up to 10 million tonnes of renewable hydrogen. Investments in renewable hydrogen production capacity are estimated at EUR 180-470 billion in the EU until 2050. The strategy identifies as a clear priority the production of renewable hydrogen, i.e. hydrogen produced through electrolysis using renewable electricity. In this context, a top priority is to demonstrate larger size, more efficient and cost-effective electrolysers, with capacities reaching 100 MW and above. Another priority is to further develop large scale hydrogen end-use applications, notably in industry. The path to business case feasibility (without any grant component) of the solution at potential replication sites shall also be investigated. The necessary coordination, along the value chain with the European Clean Hydrogen Alliance³⁷², and on data and knowledge with the observatory and data base in the Clean Hydrogen Joint Undertaking, is foreseen.
- *Sustainable aviation fuels (SAF).* Though aviation accounted for only 3.7% of total CO₂ emissions in the EU in 2018, it accounted for 15.7% of CO₂ transport emissions.

³⁷⁰ <https://www.eib.org/en/products/mandates-partnerships/innovfin/products/energy-demo-projects.htm>

³⁷¹ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301>

³⁷² https://ec.europa.eu/growth/industry/policy/european-clean-hydrogen-alliance_en

Aviation is the second highest transport sector after road vehicles, and the fastest growing. Reducing aviation emissions is challenging considering the long operational life of aircraft and the fact that zero-emission aircraft configurations and powertrain options for commercial air transport are far from technological and commercial maturity. SAF can significantly reduce aviation reliance on fossil fuels, while relying on existing infrastructure and propulsion systems, but the transition will require significant investments. While several SAF production pathways are certified, their use in the fuel mix is still negligible (less than 0.1%) due to high production costs. The price of the most innovative and sustainable types of fuels is estimated at up to 3 to 6 times the price of fossil aviation fuels depending on the production pathway, while their lifecycle emissions savings are 85% or more compared to fossil fuels. The path to business case feasibility (without any grant component) of the solutions at potential replication sites shall also be investigated as well as sustainability in wider scale as part of the Fit-for-55 package. The Commission has therefore proposed the ReFuelEU Aviation initiative³⁷³ to boost the supply and use of sustainable aviation fuels in the EU. The action will support the development of the most innovative SAF *notably advanced biofuels and RFNBOs*³⁷⁴ in line with the ReFuelEU Aviation and Renewable Energy Directive sustainability framework.

- *Long duration energy storage (LDES)*. At any moment in time, electricity consumption and generation have to be perfectly matched. This balance is necessary not only in the short term for power grid stabilisation (for which short duration storage solutions exist), but also over the long term, to ensure supply adequacy, by compensating for fluctuations, for meteorological dark and still periods ('dunkelflaute') that can last a few weeks, and for seasonal variations between summer and winter. Long duration – weekly to seasonal - renewable grid scale energy storage needs will expand as both the electrification of demand and the share of renewable – and variable as well as distributed - energy sources in the total supply mix will grow. Sustainable long duration energy storage therefore has a key role to play in the transition towards a carbon-neutral economy. The storage system needs to be optimised for large capacity and long duration (weekly, seasonal), for minimal climate and environmental footprint over the full life cycle, for regulatory compliance and for financial viability (hence maximising round trip efficiency, minimising costs and identifying a business case for the targeted investment based on electricity storing / de-stocking price projections). The path to business case feasibility (without any grant component) of the storage solution at potential replication sites shall also be investigated. Sustainable storage solutions for renewable energy, involving an energy vector that can be used for other purposes than regenerating electricity are also eligible. The topic is open to all technologies: chemical (including hydrogen and its derivatives), electrochemical, thermal and mechanical technologies (other than pumped hydro which is mature and available commercially).

³⁷³ Commission proposal for a Regulation of the European Parliament and the Council on ensuring a level playing field for sustainable air transport (COM(2021) 561 final, 14 July 2021, 2021/0205 (COD))

³⁷⁴ Renewable Fuels of Non Biological Origin (RFNBOs) as defined under RED II.

- *Direct air capture (DAC) of CO₂*. European Commission scenarios reaching net-zero emission by 2050 show extensive use of carbon dioxide removal, including DAC. For example, the 1.5 tech scenario forecasts 266 Mt of CO₂ point capture and 200 Mt of CO₂ DAC. Most IPCC scenarios modelling 1.5°C paths also include a share of carbon dioxide removal (with and without DAC). DAC emerges as the most relevant source of carbon for renewable power-to-fuels/chemicals processes in such scenarios, but several challenges remain for a large-scale deployment of the technology. The future operational and financial viability (without any grant component or support scheme) of any DAC solution at potential replication sites shall also be investigated in function of the fate of the captured CO₂ (i.e. underground storage or use), renewable energy source used for the capture process, and vicinity to CO₂ transport and storage infrastructure (in case of underground storage). The International Energy Agency estimates the current DAC cost to be within a wide range of \$100-\$1000 per captured tonne of CO₂. Stakeholders claim that costs can be reduced to €50-€100 by 2030 with sufficient investments in R&I and deployment. As there is so far no specific EU initiative targeting DAC, this topic will fill an important gap.

Functioning of the blending operation

The blending operation will be open to all applicants meeting the set eligibility criteria set in this text and InvestEU Green Transition product. As such, it is not restricted to projects proposed under pre-existing or future partnerships with the European Commission. This blending operation is particularly relevant because it seeks to bring together the public and private sector to fund pre-commercial, industry-scale demonstration projects for critical decarbonisation technologies, directly addressing the early deployment funding gap for the selected technologies and provide a structure to accelerate their commercialisation.

Projects' selection and financing procedure follows the InvestEU Regulation. In particular, the EIB or other implementing partners will check the financial viability of and perform full due diligence on each potential financing operation, while the Commission services assure their eligibility under the 'policy check' procedure. Special attention shall be paid to ensuring that the technologies developed, and Intellectual Property generated will benefit the EU interest, in particular by focussing the funds on high quality projects realised in the Union/eligible Associated Countries.

Expected impact

Unprecedented investment is needed to turn climate policy targets into reality. Attaining the 2030 target of at least 55% net emissions reduction is estimated to require EUR 350 billion of additional annual investment. Blended finance is a crucial tool to mobilise urgently needed private 'patient capital,' especially in domains considered too risky for the markets to function. This is the case of the technologies selected, which will benefit from investments in demonstration and scaling-up – leading to increased confidence among market participants, economies of scale in production and deployment, and significant cost reductions. The project pipeline of the InnovFin EDP and FutureMobility facility, as well as the high number of submitted proposals under the first Innovation Fund calls, indicate the richness of the EU

ecosystem, which - boosted by the Fit-for-55 package - is expected to thrive in the coming years. The initiative will accelerate the reduction of the green premium in key areas, allow for wider, faster up-take and contribute to the creation of jobs in the EU in green industries manufacturing these solutions.

Legal entities:

European Investment Bank (EIB), 98-100, boulevard Konrad Adenauer, L-2950 Luxembourg, Luxembourg

Form of Funding: Indirectly managed actions

Type of Action: Indirectly managed action

Indicative timetable: as of 1st quarter 2023 and 1st quarter 2024

Indicative budget: EUR 50.00 million from the 2023 budget and EUR 50.00 million from the 2024 budget

2. Research on aviation safety and sustainability issues to prepare future standards and regulations

While facing the effects of the COVID-19 pandemic, ground-breaking challenges are coming to the fore for the aviation industry, including the reduction of its environmental impact, the response to security threats and the need to reduce the time to market for novel services or products.

The extent of changes at stake is creating a challenge to public authorities, and notably the aviation regulators, as they imply to reconsider the existing references supporting rulemaking, certification, compliance assessment and/or standardisation. The needs to ensure the highest level of safety while maintaining a level playing field for all users, to develop the appropriate responses to new threats, to support the transition towards a sustainable aviation and to assess emerging risks keep generating new quests for regulators to fulfil their mission as guarantors of public interest – whether on safety, security, health and/or environmental protection.

The importance of these questions in the protection of public interest requires a swift handling by Aviation authorities to timely find the due responses required. Research and innovation is pivotal to instigate a new mind-set and the re-design of knowledge, processes and methodologies, so often required to devise robust and future-proof strategies and solutions best serving the interests of the aviation sector and of European citizens alike.

The modernisation of the aviation system in the areas of safety, efficiency, level playing field and environmental protection are key elements with the European Plan for Aviation Safety (EPAS³⁷⁵).

The priorities under this heading encompass the following themes:

³⁷⁵

Available at: <https://www.easa.europa.eu/domains/safety-management/european-plan-aviation-safety>

Training media allocation - simulator vs. actual flying: the allocation of training media to the various objectives and phases of pilot training have been defined several decades ago. Technological evolution of training-media, the pedagogical development in pilot training, changing economic context and environmental protection needs for aviation make the reassessment of the allocation of training-media necessary to prepare the evolutions of flight training standards.

New intelligence solutions exploiting big data technologies and data science: building on the capacities of the ‘Data4Safety’ (D4S) programme (coordinated by EASA) and exploiting previous R&I initiatives, there is a need to mature new intelligence solutions building on big data technologies and data science and to make them available to a larger community of aviation actors and stakeholders.

These new intelligence solutions are expected to be matured in view of (1) a generalised use in aviation safety risk management, (2) their application to other aviation domains such as security, cyber-security, environmental protection, operational efficiency and training and (3) their potential application to other transport modes and sectors.

Evolutions of airworthiness standards for new aircraft structure designs using materials, processes and advanced manufacturing methods: review of design practice suggests that composite structures now applied to aircraft principal structural elements have been designed largely based upon experience and limited understanding and quantification of the many competing failure modes. Furthermore, lack of a standard approach to design for damage no-growth (the usual expected philosophy) and communication challenges throughout complex supply chains have complicated the matter.

In addition, the environmental (e.g. thermal, moisture) coefficient differences which exist between some materials in hybrid structural configurations (mixed material) can be significant and difficult to predict in complete structures in service, sometimes resulting in unexpected damage in service (in the metallic and/or composite structure).

The research action is aimed at supporting the development of certification requirements, means of compliance, and associated guidance applicable to one, or more, of EASA products and/or other emerging products, e.g. Vertical Take-off and Landing (VTOL) aircraft.

Aviation Resilience - Cybersecurity Threat Landscape: The increasing connectivity of aircraft and ground systems with the use of internet technologies or aeronautical communications, raises an emerging risk of remotely compromising aircraft systems, as claimed by the hackers’ community.

To be able to correctly evaluate the risks from cybersecurity threats on aviation and their acceptability, it is first necessary to establish the impact on the safety of flights, taking into account for instance types of operations being conducted, pilots’ situational awareness, and traffic situation. Some threats have already been evaluated by analysis but an end-to-end evaluation is needed due to the human factor issues involved, both in the cockpit and on the

ground segment. As new ‘entrants’ to aviation, drone operations represent one specific domain to address as part of the project.

New health safety measures in aircraft: the COVID-19 crisis has revealed again the critical role of air transport in accelerating the transmission of infectious diseases, as it was previously observed for the severe acute respiratory syndrome (SARS) in 2002/03, the influenza H1N1 virus in 2009.

Ensuring the preparedness of the air transport system to achieve a strong resilience to infectious disease outbreak or high-threat pathogen events, is now an essential enabler for the economical sustainability of the air transport sector.

The objectives of the project are to investigate the possibilities to further reduce the spread of a series of airborne infectious agents (viruses, bacteria, fungi) within the aircraft environment by improving filtration systems, recirculation systems and cabin airflow, including individual air supply nozzles, to ensure that passengers are not adversely affected during the flight.

Colour vision requirements in the new full glass cockpit environment and modern ATCO consoles: recently, major progress in aircraft design as well as in the development of air traffic control (ATC) stations, including full glass cockpit, LED displays and other technologies. In order to increase the safety and decrease the reaction times a lot of information provided to pilots and ATC controllers is colour coded.

Fulfilment of targeted research needs on aviation standards, notably those evolving from the needs for mitigation of occurred accidents/incidents, perceived emerging threats and other international obligations of EASA and European States at large – namely those in the framework of ICAO.

Strengthening and coordinating a European network of experts in support to non-CO2 emission impact assessment and policy option assessment: the understanding of the climate impact of aviation non-CO2 emissions is constantly evolving, the recent report from the Commission and EASA³⁷⁶ highlighted the need to reduce these uncertainties in order to implement effective mitigation policy measures pursuant to Article 30(4) of the EU Emissions Trading System Directive.

Developing, agreeing and implementing an effective policy response to the issue of the climate impact of non-CO2 emissions from the aviation sector requires a coordinated effort and consensus across a wide range of relevant stakeholders (e.g. scientific community, academia, aircraft operators, fuel producers, ANSPs, NGOs, regulators, analysts and policymakers at EU / State level). The measures can be clustered into three categories: financial/market-related, fuel standards/aircraft engine emission standards and specific operational measures.

³⁷⁶ Available at: <https://www.easa.europa.eu/document-library/research-reports/report-commission-european-parliament-and-council>

The project encompasses the establishment of a non-CO2 science network (incl. EU and non-EU teams), the consolidation of the series of recent research project results, the evaluation with on-going/planned projects on required actions to address open issues and gaps as well as the definition of the roadmap for enhanced impact assessment capabilities. The results will also support work on the climate impact of non-CO2 emissions in the ICAO Committee on Aviation Environmental Protection (CAEP).

Legal entities:

European Union Aviation Safety Agency (EASA), Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany

Form of Funding: Indirectly managed actions

Type of Action: Indirectly managed action

Indicative timetable: as of 1st quarter 2024

Indicative budget: EUR 8.50 million from the 2024 budget

Expert contract actions

1. Experts for the monitoring of actions

This action will support the use of appointed independent experts for the monitoring of running actions (grant agreement, grant decision, public procurement actions, financial instruments) funded under Horizon Europe and previous Framework Programmes for Research and Innovation, and where appropriate include ethics checks, as well as compliance checks regarding the Gender Equality Plan eligibility criterion.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative timetable: As of 1st quarter 2023 and 1st quarter 2024

Indicative budget: EUR 0.80 million from the 2023 budget and EUR 0.80 million from the 2024 budget

2. External expertise to advise on EU research and innovation policy

This action will support the provision of independent expertise in support of the design, implementation and valorisation of EU research policy. Individual experts will work in the following domains:

- Analysis, design, assessment and implementation of strategic climate, energy and mobility research and technology options and actions

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- Future climate, energy and mobility -related research actions and programmes, contribution to their impact assessment.
- International cooperation in the field of climate, energy and mobility research and innovation.
- Analysis and valorisation of EU climate, energy and mobility research results in view of contributing to the elaboration of policy reports (such as projects for policy, project cluster reports, etc.).
- Preparation of actions for Horizon Europe missions.

The tasks of individual experts would include:

- Analysis of the contribution of the funded research to the EU policy objectives spanning across all climate, energy and mobility modes and systems;
- Analysis of the state-of-the-art at international level; investigation of deployment options for the developed knowledge;
- Participation in international symposia, including the drafting of White Papers and reports on the symposia's conclusions;
- Advise the Commission on promising technologies covered by European and nationally funded projects and on ways to stimulate synergies;
- Assist the Commission in the evaluation of calls for expression of interest.

In addition to individual experts, this action could provide for Commission expert groups.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative timetable: As of 1st quarter 2023 and as of 1st quarter 2024

Indicative budget: EUR 0.60 million from the 2023 budget and EUR 1.00 million from the 2024 budget

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Budget³⁷⁷

	Budget line(s)	2023 Budget (EUR million)	2024 Budget (EUR million)
Calls			
HORIZON-CL5-2023-D1-01		107.50	
	<i>from 01.020250</i>	49.00	
	<i>from 01.020250 - NGEU</i>	58.50	
HORIZON-CL5-2023-D1-02		10.00	
	<i>from 01.020250</i>	10.00	
HORIZON-CL5-2024-D1-01			103.00
	<i>from 01.020250</i>		103.00
HORIZON-CL5-2023-D2-01		104.70 ³⁷⁸	16.30
	<i>from 01.020250</i>	64.68	16.30
	<i>from 01.020250 - NGEU</i>	40.02	
HORIZON-CL5-2023-D2-02		42.00	
	<i>from 01.020250</i>	42.00	
HORIZON-CL5-2024-D2-01			72.00
	<i>from</i>		72.00

³⁷⁷ The budget figures given in this table are rounded to two decimal places.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

³⁷⁸ To which EUR 7.00 million from the 'Digital, Industry and Space' budget will be added making a total of EUR 111.70 million for this call.

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	<i>01.020250</i>		
HORIZON-CL5-2024-D2-02			39.00
	<i>from 01.020250</i>		<i>39.00</i>
HORIZON-CL5-2023-D3-01		401.10	22.50
	<i>from 01.020250</i>	209.98	22.50
	<i>from 01.020250 - NGEU</i>	191.12	
HORIZON-CL5-2023-D3-02		161.00	
	<i>from 01.020250</i>	161.00	
HORIZON-CL5-2023-D3-03		64.60	
	<i>from 01.020250</i>	64.60	
HORIZON-CL5-2024-D3-01			246.00
	<i>from 01.020250</i>		<i>246.00</i>
HORIZON-CL5-2024-D3-02			138.00
	<i>from 01.020250</i>		<i>138.00</i>
HORIZON-CL5-2023-D4-01		78.00	
	<i>from 01.020250</i>	36.18	
	<i>from 01.020250 - NGEU</i>	41.82	
HORIZON-CL5-2023-D4-02		44.00	
	<i>from 01.020250</i>	44.00	

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HORIZON-CL5-2024-D4-01			36.00
	<i>from</i> <i>01.020250</i>		36.00
HORIZON-CL5-2024-D4-02			50.00
	<i>from</i> <i>01.020250</i>		50.00
HORIZON-CL5-2023-D5-01		217.00	
	<i>from</i> <i>01.020250</i>	95.49	
	<i>from</i> <i>01.020250 -</i> <i>NGEU</i>	121.51	
HORIZON-CL5-2024-D5-01			202.05
	<i>from</i> <i>01.020250</i>		202.05
HORIZON-CL5-2023-D6-01		108.50	
	<i>from</i> <i>01.020250</i>	108.50	
HORIZON-CL5-2024-D6-01			122.50
	<i>from</i> <i>01.020250</i>		122.50
Contribution from this part to call HORIZON-MISS-2023-CIT-02 under Part 12 of the work programme		3.39	
	<i>from</i> <i>01.020250</i>	3.39	
Contribution from this part to call HORIZON-MISS-2023-CLIMA-01 under Part 12 of the work programme		54.82	
	<i>from</i> <i>01.020250</i>	54.82	
Contribution from this part to call HORIZON-MISS-2023-OCEAN-01 under Part 12 of the work programme		62.14	
	<i>from</i> <i>01.020250</i>	62.14	
Contribution from this part to call		57.15	

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HORIZON-MISS-2023-CIT-01 under Part 12 of the work programme	<i>from</i> <i>01.020250</i>	57.15	
Contribution from this part to call HORIZON-MISS-2023-CLIMA-CITIES-01 under Part 12 of the work programme		26.82	
	<i>from</i> <i>01.020250</i>	26.82	
Contribution from this part to call HORIZON-MISS-2023-CLIMA-OCEAN-SOIL-01 under Part 12 of the work programme		6.85	
	<i>from</i> <i>01.020250</i>	6.85	
Contribution from this part to call HORIZON-MISS-2023-OCEAN-SOIL-01 under Part 12 of the work programme		5.67	
	<i>from</i> <i>01.020250</i>	5.67	
Other actions			
Grant to identified beneficiary according to Financial Regulation Article 195(e)		1.75	0.25
	<i>from</i> <i>01.020250</i>	1.75	0.25
Public procurement		15.50	3.20
	<i>from</i> <i>01.020250</i>	15.50	3.20
Subscription action		1.16	1.78
	<i>from</i> <i>01.020250</i>	1.16	1.78
Provision of technical/scientific services by the Joint Research Centre		2.70	2.00
	<i>from</i> <i>01.020250</i>	2.70	2.00
Indirectly managed action		50.00	58.50
	<i>from</i> <i>01.020250</i>	50.00	58.50
Expert contract action		1.40	1.80
	<i>from</i> <i>01.020250</i>	1.40	1.80

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Contribution from this part to Expert contract action under Part 12 of the work programme		0.57	
	<i>from 01.020250</i>	<i>0.57</i>	
Contribution from this part to Indirectly managed action under Part 12 of the work programme		7.00	
	<i>from 01.020250</i>	<i>7.00</i>	
Contribution from this part to Specific grant agreement under Part 12 of the work programme		27.15	
	<i>from 01.020250</i>	<i>27.15</i>	
Estimated total budget		1662.47	1114.88