Working document for the work programme 2025

Cluster 5: Climate, Energy and Mobility

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DISCLAIMER

This document has not been adopted or endorsed by the European Commission. Any views expressed are the preliminary views of the Commission services and may not in any circumstances be regarded as stating an official position of the Commission. The information transmitted is intended only for the Member State or entity to which it is addressed for discussions and may contain confidential and/or privileged material.

Please note that:

- This document is **work in progress and subject to changes - topics may be added, changed and/or removed.**
- **Calls and deadline models** are not yet included in this draft.
- **The identification of lump-sum topics is not yet completed.** Additional topics will be selected for lump sum implementation.
- **Cross-cutting issues** (e.g. SSH integration, biodiversity, international cooperation) have **only partially been integrated** in the current version.
- This version contains only **Other Actions** that are closely linked to a thematic portfolio of actions. Additional Other Actions will be added at a later stage.
- This document does **not yet comply with the new template for Horizon Europe work programmes**.
- This document **does not include budget indications for topics or grants.** All activities included in this document are **subject to budget availability.**

Introduction

[policy introduction to be added later]

Activities in this work programme will contribute to all **Key Strategic Orientations (KSOs)** of the Strategic Plan:

- **The green transition**: Horizon Europe R&I activities must support Europe to become the world's first climate-neutral continent by 2050 and to tackle biodiversity loss and pollution. At least 35% of Horizon Europe's resources are committed to be spent on climate action and 10% for 2025-2027 on biodiversity action.

- **The digital transition**: Research to support the digital transition is key to Europe's competitiveness and open strategic autonomy, and to setting human-centred standards. It is also key to achieving the green transition. In 2021-2027, it is agreed to invest at least EUR 13 billion from Horizon Europe in core digital technologies.

- **A more resilient, competitive, inclusive and democratic Europe**: Europe's democratic values and principles need a strong foundation so they can be promoted globally. Horizon Europe research activities will help provide this foundation. This includes research on civil security, on a fair and environmentally friendly economic model, on health and wellbeing and on democratic participation.

Open strategic autonomy and securing Europe's leading role in developing and deploying critical technologies are overarching principles that apply across all three key strategic orientations.

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. Activities can have a cross-cutting character and will, in practice, 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 2025-2027)**	**Destination** **(Cluster 5 work programme 2025)**
21. Advancing science for a transition to a climate-neutral and resilient society	1. Climate sciences and responses for the transformation towards climate neutrality
22. Facilitating a clean and sustainable transition of the energy and transport sectors towards climate neutrality through cross-cutting solutions	2. Cross-sectoral solutions for the climate transition
23. Ensuring more sustainable, secure and competitive energy supply through solutions for	3. Sustainable, secure and competitive

smart energy systems based on renewable energy solutions	energy supply
24. Using energy in buildings and industry in an efficient, affordable and sustainable way	4. Efficient, sustainable and inclusive energy use
25. Achieving sustainable and competitive transport modes	5. Clean and competitive solutions for all transport modes
26. Multimodal systems and services for climate-neutral, smart and safe mobility	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.

Cluster 5 supports the EU's strategic objectives through activities included in this work programme and through the support of **Institutional European Partnerships**[1] 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 mode[2].

Horizon Europe is the EU's research and innovation support programme in a system of European and national funding programmes that shares policy objectives. Projects that have been awarded a grant under a Horizon Europe 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

[1] Clean Hydrogen, Transforming Europe's rail system, Integrated Air Traffic Management, Clean Aviation

[2] 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

programmes (such as European Regional Development Fund (ERDF)[3], European Social Fund Plus (ESF+)[4], Just Transition Fund[5], LIFE[6], Innovation Fund[7], InvestEU[8], European Defence Fund (EDF)[9]), where appropriate, as well as private funds or financial instruments.

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)[10]. 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. This work programme **pilots the better integration of societal readiness considerations into projects** (more information at the end of the introduction).

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

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

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

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

6 https://ec.europa.eu/environment/archives/life/index.htm

7 https://ec.europa.eu/inea/en/innovation-fund

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

9 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.

10 https://eit.europa.eu/our-communities/eit-innovation-communities

through the Mission Innovation[11] 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.

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).

[11] http://mission-innovation.net/our-work/innovation-challenges/

Specific requirements for Societal Readiness pilot projects:

The pilot is aimed at testing the introduction of the Societal Readiness consideration for a limited number of topics from Work Programme 2025 within Cluster 5. The setup of a common methodology that calls applicants to build up the elements of reflection on Societal Readiness at Work Programme level is yet innovative: the outcomes of the pilot will therefore be closely assessed and analysed before possible wider future use.

The Societal Readiness approach aims, when integrated into R&I processes, to improve the consideration of different societal needs and concerns when developing innovations and respond to them, thereby increasing the potential for societal uptake. The Societal Readiness approach aims at engaging the genuine, sufficient, and continuous involvement of all types of project partners – including Science, Technology, Engineering and Mathematics (STEM) and Social Sciences and Humanities (SSH) profiles – in an interdisciplinary setup, which serves the objectives of the topic, including from their early participation in proposal development.

Definitions related to this Societal Readiness pilot can be found in the Horizon Europe Guide [*TBC, see doc in annex*].

Proposals submitted for topics that include a request to follow the Societal Readiness approach must meet all the requirements listed below:

- Resources should be meaningfully distributed to cover project activities associated with advancing Societal Readiness. Societal Readiness considerations should be integrated transversally in the proposal, either in a set of tasks across work packages associated with the R&I work, or in the form of a transversal work package.

- Partners involved should bring sufficient expertise to support Societal Readiness activities via the inclusion of the appropriate SSH disciplines. SSH experts will facilitate the social-technological interface and enable the design of project objectives, work packages and tasks compatible with Societal Readiness related activities.

- Partners from all types and disciplines in the consortium, according to the relevance of their involvement, should be included in Societal Readiness activities, building on interdisciplinarity efforts to facilitate knowledge integration.

- Proposals should clearly address, under section *1.2 Methodology*, how the project will integrate Societal Readiness throughout the proposed work, by demonstrating the uptake of the Societal Readiness guiding questions relevant to the subject (see section below).

- Proposals should allocate reasonable resources to engage with the Coordinating and Support Action [*Topic Code*], as part of a dedicated task.

- A public deliverable report called *First report on Societal Readiness* should be elaborated within the first six months of the project. The report will build on the preliminary plans set out in the proposal. It will primarily focus on their Societal

Readiness vision (including associated reflections and responses to the guiding questions), accompanied by plans on how it will be achieved (e.g., time plan, roles and responsibilities, relation to tasks/work packages).

- A public deliverable report called *Final report on Societal Readiness* should be elaborated within the last three months of the project. The report will reflect upon the expectations versus experiences of working towards Societal Readiness, including challenges and failures; the ways in which different societal actors were identified and engaged, as well as their concerns identified and responded to; and recommendations for other future projects wishing to work on similar priorities. The *Final report on Societal Readiness* is expected to directly address the questions identified in the *First report on Societal Readiness*.

The standard template and the page limit of the Application Form remains unchanged as the proposed work reflects an integration of Societal Readiness consideration into the project design.

Societal Readiness guiding questions:

The following guiding questions[12] are offered to support project teams in considering and integrating a Societal Readiness approach in proposals and, subsequently, in projects' implementation. Consideration of questions in the proposal stage helps to ensure a consortium is well positioned to advance Societal Readiness during project implementation. This consideration includes reflecting upon the four dimensions of Responsible Research and Innovation (RRI) namely reflection, inclusion, anticipation, and responsiveness, as indicated next to each question (see complete definition of RRI in Horizon Programme Guide). The following guiding questions are offered as a basis for reflection and can be complemented by other considerations specific to the topic's subject.

- R&I Goals**:** How do the objectives and expected results of the proposal reflect the diverse needs or goals of different groups potentially involved or affected? *(RRI dimensions: reflection, inclusion, responsiveness)*

- Societal actors: How does the proposal identify and include key stakeholder groups in activities? If appropriate, how does the proposal identify and include groups often marginalised or excluded from previous or similar initiatives? *(RRI dimensions: reflection, inclusion)*

[12] The questions that follow are condensed from and based on the Societal Readiness Thinking Tool elaborated within the EU-funded project NewHoRRIzon, and subsequently detailed in Bernstein, M. J., Nielsen, M. W., Alnor, E., Brasil, A., Birkving, A. L., Chan, T. T., Griessler, E., de Jong, S., van de Klippe, W., Meijer, I., Yaghmaei, E., Nicolaisen, P. B., Nieminen, M., Novitzky, P., & Mejlgaard, N. (2022). The Societal Readiness Thinking Tool: A Practical Resource for Maturing the Societal Readiness of Research Projects. *Science and Engineering Ethics*, *28*(1), 6. https://doi.org/10.1007/s11948-021-00360-3

- Benefits and burdens: Who stands to benefit from envisioned activities of the project and their expected impacts? Who stands to bear the burdens? How are the groups bearing these burdens included and given a voice in the project? How are possible conflicts of interest managed? *(RRI dimensions: anticipation, reflection, responsiveness)*

- Objections and concerns**:** How does the project, through its activities, plan to identify and respond to the objections or concerns of different groups of stakeholders? How might potential undesired consequences of activities, results, outcomes, or impacts be anticipated? How might such consequences be avoided? *(RRI dimensions: reflection, inclusion, anticipation, responsiveness)*

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

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *"Advancing science for a transition to a climate-neutral and resilient society*".

Advancing climate science and the knowledge base necessary to underpin actionable solutions is essential for catalysing the global transition to a climate-neutral and climate-resilient society.

Research should contribute to closing major knowledge gaps on the changing climate together with their associated impacts and risks, on both society and nature, and to developing tools to support decision-makers in designing and implementing effective mitigation and adaptation actions at various time and spatial scales while properly accounting for synergies and trade-offs with other policy objectives, such as just transition and leaving no one behind. Tailored scientific approaches that take into account disparities between regions, countries, communities and diverse groups within society, are needed, to understand how they are affected by global warming and what array of response options is available to them.

The first objective is to **support and accelerate climate action (both mitigation and adaptation) globally** by:

- Improved knowledge of the Earth system, its recent evolution and future responses under different global emissions pathways and socio-economic scenarios.
- Increased understanding of the interrelated impacts between climate change, human and natural systems, including from compound, cascading and tail risks, improving the attribution to anthropogenic factors, and leveraging the role of climate services for effective adaptation and response strategies.
- Well-designed and evaluated solutions and pathways for climate-resilient, low-GHG-emission development enabling just societal transformation while promoting citizen and stakeholder involvement, climate literacy and integration of natural and social sciences.
- Increased synergies with the EU Mission on Adaptation to Climate Change generating actionable knowledge in support of transformative adaptation.

The second objective contributes substantially to key international assessments by closing key knowledge gaps related to climate change. Such assessments include the ones by IPCC, IPBES, the Scientific Assessment of Ozone Depletion and other initiatives such as the Coupled Model Intercomparison Project under the World Climate Research Programme.

The third objective is a **strengthened European Research Area on climate change** by boosting scientific excellence and capacity in an inclusive manner across the participating countries.

The fourth objective is the **maximisation of synergies with other policy priorities** such as biodiversity and ecosystem preservation and restoration, just transition, just resilience, pollution reduction, health and well-being, resource conservation, circularity and the Sustainable Development Goals by exploring co-benefits, trade-offs and potential unintended consequences of climate strategies and policy interventions.

HORIZON-CL5-2025-D1-01: Climate Simulations and Knowledge for Optimal Support of IPCC Assessments and International Policy

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	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). 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: Project results are expected to contribute to **all of the** following expected outcomes:

- Decision makers can access and utilise in a timely manner scientifically robust climate projections corresponding to a range of future scenarios and their corresponding greenhouse gas (GHG) emission pathways, including those matching the Paris Agreement targets;

- Decision makers can better understand the impacts, risks and implications of the pathways involving different magnitudes and durations of temperature overshoot;

- The European research community provides a coordinated contribution to the Intergovernmental Panel on Climate Change (IPCC) and other major scientific initiatives (e.g., Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), World Climate Research Programme (WCRP), World Adaptation Science Programme (WASP), the Global Carbon Budget), in support of informing the UNFCCC process and other global and national climate efforts;

- The activities of international programmes and communities like the Integrated Assessment Modelling Consortium (IAMC), the Coupled Model Intercomparison Project (CMIP), the Coordinated Regional Downscaling Experiment (CORDEX) and Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) are better coordinated, with outcomes more consistent and better responding to specific policy needs;

- The European contribution to these programmes is supported by an improved and interconnected overarching infrastructure.

Scope:

Given the rapidly developing climate crisis, there is an increasing need for accurate, reliable, and actionable information at global to local scales, near to long timescales. This information must satisfy policy requirements. In particular, the simulations and knowledge delivered to feed the IPCC, including the Seventh Assessment Report (AR7), should be internally coherent and well-coordinated. The modelling setting ensemble and simulation design must be suited to meet societal and policy demands to support timelier European and international climate policy developments. This also implies progressing towards operational modelling frameworks that provide the best possible information for societal decision-making, bringing together the available approaches. The simulations should cover the full spectrum of climate risks. In particular, as global mitigations efforts are insufficient and temperatures continue to rise, the impacts of overshoot on the Earth system and the feasibility, possible pace, and implications of bringing the temperatures down in a sustainable way after an overshoot including potential irreversible impacts (e.g., sea level rise, ocean acidification, species extinctions, loss of glaciers, and crossing climate tipping points), need to be explored.

Therefore, actions should:

- Generate future global climate projections with state-of-the-art Earth System Models (ESM) which are built on latest improvements in modelling technologies and in process understanding with a more complete representation of climate–carbon cycle feedbacks.

- Design simulations considering the socio-economic scenarios from the most up to date set of Integrated Assessment Models (IAM). GHG emission pathways should be provided based on various societal mitigation choices and land-use scenarios. The

resulting assessment should link allowable carbon emissions with key climate targets, spanning policy relevant temporal and spatial scales.

- Delivering scenarios and simulations with different levels and durations of overshoot (to be selected for their policy relevance), assessing the corresponding risks accounting for fast and slow onset processes.

- Update and coordinate the assumptions and observational and simulated data sets underpinning the models and experiments of the climate science communities (including Earth system, sectoral impacts, adaptation and mitigation modelers) from international programmes, such as IAMC, CMIP, CORDEX and ISIMIP, optimizing the interaction between them as much as possible within the same IPCC cycle.

- Designing a framework to coordinate and incorporate global, regional and very-high-resolution climate projections using consistent concentration and emission-driven ESM, enhancing collaboration between European Earth system modelling and service provision, such as Copernicus and Destination Earth. This system should include cross-analysis and evaluation of the full suite of models, including approaches for sampling the uncertainty (e.g. emulators).

- Improve the existing infrastructure ecosystem (software, tools, data, HPC resources and services), to support the delivery of climate projections (for which a part of the budget may be allocated [<30%]. This should not replace, but be complementary to, the funding available from the European research infrastructures (ESIWACE), Euro-HPC and other 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, protocols, code, and data that is managed in compliance with the FAIR principles.

The projects funded under this call should envisage clustering activities with other relevant ongoing projects (in and outside of Horizon Europe) for cross-projects cooperation and exchange of results. All projects funded under this topic are strongly encouraged to connect, coordinate, and participate in networking, intercomparison and joint activities, as appropriate. As this endeavor should be supported by the research communities that continuously improve the modelling systems, strong feedback and coordination with the projects funded under topics HORIZON-CL5-2023-D1-01-01 and [HORIZON-CL5-2025-D1-02 “Improving Earth System Models”] is expected.

HORIZON-CL5-2025-D1-02: Improving Earth System Models

Specific conditions

Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	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). 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: Project results are expected to contribute to **all of the** following expected outcomes:

- Advanced understanding and capability to predict the future evolution of the Earth system, at global to local scales and from weather to climate timescales, and the societal and environmental impacts of these changes.
- Advanced understanding and capability to predict regional climate variability, including extreme events and regional precipitation.
- Strengthened collaboration and cross-fertilisation across alternative approaches in climate modelling science, towards a joint contribution to the next generation of Earth system models.
- Advanced science and evidence base in the longer term for supporting European and international polices.

Scope:

Earth system models (ESMs) are the primary tools used for assessing future changes in the climate system. They have increased in their resolution and realism over the past two decades. Despite these advances, there remain several poorly understood and simulated processes, interactions and climate feedbacks that limit their ability to deliver accurate predictions and projections of global and regional Earth system change, and to understand, simulate and

quantify climate variability. Specially challenging is how variability relates with extreme events, and precipitation simulation.

Actions should address all of the following aspects:

- Improving the simulation of the coupled Earth system and its sensitivity to natural and anthropogenic forcings, with a better representation of climate feedbacks and processes, including some the following advances, among others:
    - The interplay between the global and local scales, with special focus on climate extremes.
    - The coupled climate-carbon-water cycle feedbacks.
    - The climate-vegetation-fire interactions.
    - The coupled-ice sheet processes.
    - The climate-air quality interactions.
    - The interactions between land use scenarios (in terms of changes in the land use and surface with consequences on the water and carbon cycles, albedo and aerosols) and regional climate.
    - The aerosol-cloud-climate forcing and feedbacks.
- Including collaboration among approaches, such as global, regional and high-resolution modelling and others (e.g., machine learning hybrid-modelling, digital twins)
- Improving and bringing together existing and new observational and reanalysis datasets, models, emulators, and advanced analysis tools for rapid and in-depth evaluation and understanding of model simulations.

Actions should promote the highest standards of transparency and openness, extending to aspects such as assumptions, protocols, code, and data that is managed in compliance with the FAIR principles. 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.

The projects funded under this call should envisage clustering activities with other relevant ongoing projects (in[13] and outside of Horizon Europe) for cross-projects cooperation and exchange of results. All projects funded under this topic are strongly encouraged to connect,

[13] For example, projects funded under the call Climate sciences and responses, under the Work Programme 2023-2024.

coordinate, and participate in networking, intercomparison and joint activities, as appropriate. Results from relevant past and ongoing projects, including those funded by HORIZON-CL5-2023-D1-01-01, should be considered and strong feedback and coordination with projects funded under the topic HORIZON-CL5-2023-D1-01-01 and [HORIZON-CL5-2025-D1-01 "Climate Simulations and Knowledge for Optimal Support of IPCC Assessments and International Policy"] is expected.

HORIZON-CL5-2025-D1-03: Modelling of mitigation pathways for F-gases

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	
Legal and financial set-up of the Grant Agreements	The conditions are described in General Annex B. 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 Outcomes:

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

- Improved knowledge of regional pathways concerning the use of Ozone Depleting Substances and Fluorinated Greenhouse Gases, options to mitigate this use, the resulting emissions, and how this interacts with the decarbonisation of the energy system.
- Improve modelling capacity regarding the use of Ozone Depleting Substances and Fluorinated Greenhouse Gases in the refrigeration, air conditioning and heat pump sectors, in a manner that increases the availability to Parties to the Montreal Protocol of modelling tools to inform them on policy options for an ambitious implementation of the Kigali Agreement, including a transition to natural refrigerants, and how this interacts with the decarbonization of the energy system.

Scope:

Fluorinated greenhouse gases are the fastest growing group of greenhouse gas emissions globally. The Montreal Protocol resulted in decreasing use and emissions of Ozone Depleting

Substances and will now also regulate a phasedown of hydrofluorocarbons (HFCs), representing the largest share of fluorinated greenhouse gas use, of which the majority is used in refrigeration, air conditioning and heat pump equipment.

The project should improve the knowledge base of F-gas use and emission pathways under baseline conditions (i.e. policies as they are today), pathways that meet the Kigali Agreement and pathways that outperform the Kigali Agreement. The development of these pathways should cover all main regions globally, include fluorinated greenhouse gases not regulated under the Montreal protocol, assess the interaction with the energy system, notably related to the deployment of HFC-alternatives in refrigeration, air conditioning and heat pump equipment and its interaction with energy efficiency, and the deployment of SF_6 or alternatives to it in electrical switch-gear, as well as possible implications for PFAS emissions. The pathways should give detailed insights into the technologies available, including the use of F-gas free alternatives.

Most fluorinated greenhouse gas emissions are related to the use in the refrigeration, air conditioning and heat pump (RACHP) equipment. This sector is projected to be one of the highest contributors to future global energy demand increases. The action should include the development of modelling tools that allow for the representation at national level of the use of F-gases and their alternatives at least in this RACHP sector, with a view to develop tools that would allow parties to the Montreal Protocol to assess at national level different options of mitigating HFC use, and the interaction with the decarbonization of the energy system. The action should thus expand and improve the number of tools that can provide such detailed information at country level, including for the so called Article 5 Parties under the Montreal Protocol, in a manner that would improve the knowledge base for parties to implement specifically the Kigali Agreement to the Montreal Protocol as well as allow them to get insights in how to create synergies with the climate mitigation goals of the Paris Agreement, including the decarbonisation of the energy system.

HORIZON-CL5-2025-D1-04: F-gas atmospheric monitoring

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply
Legal and financial set-up of the Grant Agreements	

Expected Outcomes:

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

- Support international networks for atmospheric monitoring in their effort to improve the methodologies for regional quantification of emissions of Ozone Depleting Substances and Fluorinated Greenhouse Gases

Scope:

Whereas the Montreal Protocol has been successful in reducing the release of ozone depleting substances, unexpected increases in emissions, for instance linked to uses in chemical processes, have been recorded through atmospheric sampling. Parties to the Montreal Protocol have asked the scientific community to identify gaps in global coverage of atmospheric monitoring of controlled substances under the Montreal Protocol and to provide options on ways to enhance such monitoring.

The project action is to follow up on the scientific findings presented in this context to the Parties of the Montreal Protocol, including through the "Report of Scientific Assessment Panel to the 11th Meeting of the Ozone Research managers – White Paper - Identification of gaps in the global coverage of atmospheric monitoring of controlled substances and options to enhance such monitoring (2021) and Outcomes of the "Workshop on Costs of atmospheric Monitoring of Gases Controlled under the Montreal Protocol (Febr. 2024)", both available under *https://ozone.unep.org/meetings/12th-meeting-ozone-research-managers/pre-session-documents* and EU funded project operated by the UNEP Ozone Secretariat on 'Regional quantification of emissions of substances controlled under the Montreal Protocol' (https://ozone.unep.org/eu-funded-project-regional-quantification-emissions-substances-controlled-under-montreal-protocol).

It should do so by strengthening international research cooperation in support of existing international networks for atmospheric monitoring by identifying methodologies to enhance the regional coverage of measurements of emissions of substances controlled under the Montreal Protocol (both Ozone Depleting Substances and HFCs) and other Fluorinated Greenhouse Gases that are effective and cost efficient. This should include a demonstration of the deployment of such methodologies by performing in at least 3 different locations in-situ measurements for at least 2 consecutive years. The locations should cover different regions at a global scale that are identified as representing a gap in atmospheric monitoring of relevance to identify possible sources of likely emissions.

HORIZON-CL5-2025-D1-05: The attribution to climate change, and improved forecasting of extreme climate- and weather-related events and their impacts

Specific conditions	
Expected EU contribution per project	
Indicative budget	

Type of Action	Research and Innovation Action
Eligibility conditions	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). 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 Outcomes:

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

- Advanced understanding of the causality between anthropogenic climate change and the frequency and intensity of climate and weather extremes, and their risks and impacts on human and natural systems.
- Improved methodologies and tools of attribution for extreme climate- and weather-related events, and their impacts, to anthropogenic climate change.
- Existing global databases of extreme events, impacts and their attribution are contributed to, or a new database is created.
- Advanced knowledge of how attribution science can be operationalized for a range of policy purposes, such as informing and improving civil protection and humanitarian planning for future extreme and slow-onset events, post-disaster reconstruction, resilience and adaptation plans.

Scope:

Extreme climate and weather events existed already before human activity started to influence the climate and would continue to occur also without climate change. However, anthropogenic climate change influences the intensity and likelihood of extreme weather events. Attribution tries to answer the question of what the role of anthropogenic climate change is for a given extreme climate or weather event.

The science of attribution is relatively nascent, and while it is fast advancing, numerous gaps remain, including on compound and cascading events, the interplay between slow and fast onset events, the appropriate statistical methods, and the proper consideration of various degrees of vulnerabilities and exposure.

Some tail events, risks and impacts inherently have very low signal to noise levels in current simulation records. Building on latest numerical and Artificial Intelligence and Machine Learning surrogate modelling efforts, counter-factual datasets using large ensembles and digital twins for example could increase the sample size of simulated rare – including compound and cascading - events and offer more robust means to explore the decision-making and estimated impact space (e.g., water, air pollution policies, land use – and their combination). Propagating uncertainties along the causality chain is an important aspect in this context.

Research needs range from climate research and advances in the interplay between natural variability and anthropogenic climate change both in the recent past and in the near-term future, to research needs focused on the interplay between climate and non-climate drivers of impacts. More research is also needed for the operationalization of attribution science for disaster risk reduction, disaster preparedness and prevention, capacity building, and enhancement of climate services, as well as post-disaster reconstruction, resilience and adaptation to current and future hazards.

The results will serve as a basis to ensure policies and actions that follow from the attribution studies can integrate climate justice. Actions should address all of the following aspects:

- Advance methodologies to collect diverse in-situ and remote sensing observations to develop robust databases.

- Focus on climate hazards, direct, indirect, and cascading impacts, locally implemented responses, and their limits (response capacities).

- Advance attribution science through a combination of observations, models, attribution methodologies applied to the physical climate conditions (fast and slow-onset event attribution for a more accurate estimation of how the likelihood and intensity of the hazards have been altered by anthropogenic climate change) and impacts (identifying how the interplay between anthropogenic climate change and local implemented responses affects residual impacts).

- Deliver enhanced methods to separate the effects of climate trends (including in extreme events) from trends in exposure and vulnerability, both in observed datasets and in model scenarios.

- Support the evolution of attribution components of climate services by building on latest extreme event causality and impact-based science and methodologies.

- Strive to develop multi-model and intercomparison approaches (e.g., ISIMIP).

- Improve modelling skills for improved forecasting of extreme climate- and weather-related events and their impacts as a function of global change.

- Improve the knowledge of how to operationalise the attribution of past events for informing future planning including in some of the areas relevant for advancing disaster preparedness and prevention capacity building, humanitarian aid operations, and adaptation plans (e.g., early warning systems, disaster risk reduction, emergency relief) via co-design and co-production with operational actors globally and with due consideration of associated challenges in the Global South.

- Address extreme and slow-onset events that are considered in the EUCRA, national climate risk assessments and the IPCC assessments.

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, protocols, code, and data that is managed in compliance with the FAIR principles.

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.

The projects funded under this call should envisage clustering activities with other relevant ongoing projects for cross-projects cooperation and exchange of results. All projects funded under this topic are strongly encouraged to connect, coordinate, and participate in networking and joint activities, as appropriate. Results from relevant past and ongoing projects, including those funded by H2020-LC-CLA-2018-2019-2020, should be considered.

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

HORIZON-CL5-2025-D1-06: Adaptation: Effectiveness and Limits

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	The conditions are described in General Annex B.

Expected Outcomes:

The actions are expected to contribute to achieve all the following expected outcomes:

- Adaptation communities - from researchers to practitioners and decision makers - have an improved understanding of the factors driving adaptation limits [14] and effectiveness[15].
- Practitioners can select and prioritize adaptation solutions and decision makers gain better insights into adaptation policies from improved and more consistent comparability of adaptation options.
- The limits and effectiveness of adaptation strategies are evaluated by a comprehensive, multidimensional set of criteria within a standardized methodology, thus contributing to the work of the Intergovernmental Panel on Climate Change (IPCC). A scientific contribution for updating the 1994 IPCC Technical Guidelines on impacts and adaptation is provided.
- Decision makers at all relevant levels of governance (local, national, and European) are provided with a consistent framework for monitoring, evaluation, and adjustment of their adaptation strategies, both in the short term (for more effective disaster prevention and preparedness) and in the long term (for more effective transformative adaptation pathways).

Scope:

The effectiveness of adaptation measures depends, among other factors, on the magnitude and rate of warming, which can lead to context-specific hard limits being encountered. However, the scientific evidence related to adaptation effectiveness remains limited, and providing a universal definition of what constitutes effective adaptation is challenging. This is motivated by difficulties in defining baseline conditions given the dynamic nature of the adaptation, in measuring avoided impacts and in establishing causality, but also by the long lead time until responses show outcomes, and limited understanding of trade-offs across spatial scales. Ex-ante and ex-post monitoring and evaluation of adaptation at different timelines and scales is also critical but currently is scarcely implemented. It is urgent to better understand and assess adaptation effectiveness and limits to increase adaptive capacity, resilience against extreme, and slow onset, non-extreme events, and to reduce vulnerability.

[14] Adaptation limits: The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions. Hard adaptation limit – No adaptive actions are possible to avoid intolerable risks. Soft adaptation limit – Options may exist but are currently not available to avoid intolerable risks through adaptive action

[15] Effectiveness: refers to the extent to which an action reduces vulnerability and climate-related risk, increases resilience, and avoids maladaptation (IPCC, 2022)

The actions should generate assessments of the effectiveness and limits of adaptation options based on quantitative and empirical evidence (privileging scientific literature but systematically integrating insights from grey literature), methodologically sound (replicable and with new metrics and indicators informed with uncertainty) and comprehensive in the criteria considered (such as economic, technological, institutional, sociocultural, geophysical, environmental and cross-cutting). Cross-cutting criteria to be included are the contribution of the adaptation solutions to mitigation, their ability to reduce cascading, compound effects and risks transmission, the degree of use of nature-based solutions (NBS), together with the feasibility, the ambition level, and their contribution to equity and justice. Other relevant aspects that should be considered are the exogenous factors, the gender dimension, the governance and the barriers and enablers.

Actions should evaluate adaptation effectiveness and limits as a function of time and for a comprehensive range of warming rates. Links between long- and short-term adaptation and adaptation limits should be established.

Actions should address all of the following aspects:

- Further the understanding of the general and context specific drivers of adaptation effectiveness and limits.
- Develop a methodology to assess the effectiveness and limits of adaptation options in a consistent way, assuring comparability among assessments. Such a methodology should:
    - Synthesize different sources of observational and modelling data that are relevant at the regional or sectoral levels to assess multiple dimensions of effectiveness and adaptation limits over time.
- Have sufficient common core elements to ensure consistency and comparability among regions and sectors, and sufficient flexibility to reflect their contextual specificities.
- Include a comprehensive set of measurements and indicators to characterize adaptation as a process and assess the multiple dimensions and aspects of adaptation effectiveness and limits.
- Test and apply the methodology for the following purposes:
    - To evaluate the effectiveness of advanced and short-term planned adaptation strategies, for a variety of European environmental conditions and socio-economic sectors or regions. Collaboration with the EU Mission on Adaptation to Climate Change is strongly encouraged, for example, by using Mission’s signatories as test cases.

- To inform the timeline and likelihood of emergence of context-specific (i.e. regions and sectors) limits to adaptation in a warming world, with an emphasis on societal, climate and biodiversity hotspots.

- Synthesizing the results as usable knowledge for practitioners and decision makers, and communicating and disseminating them using existing platforms (e.g. expanding the Climate-ADAPT platform of EEA or other options)

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.

The methodology should be jointly developed and consistent among the projects resulting from this call - for assuring this, the funded projects must dedicate a sufficient part of their budget (~at least 20%) to collaborate with sister projects funded under this topic in the design and development of the common core of the methodology. Then, the methodology should be separately extended by individual projects to address EU regional and sectoral contexts (e.g., by specific modules) maintaining methodological consistency with the core part. It should build on existing data and approaches, such as those proposed by GAMI[16], EUCRA[17], WASP[18], global funds[19], European Investment Bank (EIB), World Bank and other relevant sources.

In addition, the projects funded under this call should envisage clustering activities with other relevant ongoing projects, in and outside of Horizon Europe, for cross-projects cooperation and exchange of results. Synergies should also be ensured with the projects funded under the topic HORIZON-MISS-2024-CLIMA-01-03 on the development of indicators. Also, projects funded under HORIZON-MISS-2022-CLIMA-01-06 can be considered for synergies with NBS.

HORIZON-CL5-2025-D1-07-SRP: Fostering equity and justice in climate policies

Specific conditions	
Expected EU contribution	

[16] https://globaladaptation.github.io/
[17] https://www.eea.europa.eu/publications/european-climate-risk-assessment
[18] https://wasp-adaptation.org/wasp-publications/wasp-brief-7-advancing-effectiveness-for-climate-adaptation#:~:text=This%20WASP%20brief%20looks%20at%20the%20Advancing%20Effectiveness%20for%20Climate%20Adaptation.&text=Evaluating%20the%20effectiveness%20of%20adaptation,and%20achieved%20other%20intended%20outcomes.
[19] For example, Least Developed Countries Fund (LDCF), Special Climate Change Fund (SCCF), Global Climate Facility (GCF), Adaptation Fund (AF).

per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The consortium must include at least two partners from the Global South countries[20]
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply:

Expected Outcomes:

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

- Climate policies are made more inclusive, facilitating high levels of ambition and acceptance across political and societal stakeholders with various socio-economic and development status, both in the EU and globally.
- There is improved consensus between the Global North and the Global South within the UNFCCC process, unlocking a greater momentum in the implementation of the Paris Agreement.
- The evidence base underpinning IPCC assessments is strengthened, diversified, and made more inclusive, facilitating smoother government approval processes.
- Social science perspectives on justice and equity are better incorporated into policy narratives, scenarios, and models, improving their societal relevance and ensuring that climate action strategies are more reflective of diverse societal needs and values.
- Research capacities in the Global South countries are reinforced, facilitating a more diverse and balanced regional participation in research design and implementation.
- Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake, and building trust in results and outcomes.

Scope:

[20] http://www.fc-ssc.org/en/partnership_program/south_south_countries

Climate change and transition to low-carbon climate resilient future raise complex justice questions around equitable sharing of benefits and burdens of mitigation and adaptation efforts, not only animating global climate negotiations, but also increasingly emerging as a central issue for national politics, and for the society at large. Existing inequalities between and within countries are being exacerbated by impacts of climate change, and with growing evidence on how the most vulnerable are disproportionally at risk from climate change, climate justice is emerging as both a critical enabler and a potential barrier for shaping ambitious climate action. This creates a strong case for prioritising research on advancing just climate transitions.

For example, mitigation scenarios that have informed and influenced global climate policymaking and target-setting, and form a vital component of IPCC assessments, have been criticised for not considering fairness more explicitly and systematically, but also with regard to their transparency. These shortcomings create a barrier to their acceptance as a basis for global mitigation and adaptation efforts, in particular among policymakers from developing countries. In turn, to avoid exacerbating existing vulnerabilities and creating maladaptation, adaptation planning and implementation needs to pay more attention to the diverse spatial, temporal, and socio-political contexts that can influence how fair adaptation process and outcomes are.

Actions should advance more comprehensive and interdisciplinary understanding of climate justice in the context of mitigation and adaptation policies, taking into consideration socio-economic and development disparities that exist between regions, countries, and various segments of the population. Among others, actions should address some of the following aspects:

- Develop a new generation of global mitigation pathways, including those consistent with limiting warming to 1.5° C, better integrating justice and equity, differences in regional outcomes and with a wide range of economic and demographic assumptions;
- Enhance clarity, consistency, comparability and transparency across pathways with regard to different justice aspects;
- Evaluate the feasibility and coherence of proposed approaches in terms of, for example, investments, financial flows, governance and institutional needs;
- Analyse distributional outcomes of policies on the well-being and living standards of people with different socio-economic and development backgrounds; better representing heterogeneity to detect effects on vulnerable sectors and population segments;
- Investigate approaches alternative to economic efficiency, (global) welfare maximisation and a broader spectrum of policies, beyond (globally uniform) carbon pricing;
- Explore the role of values, political economy, power structures, socio-economic and other contextual factors (e.g., development models, climate elites, age and gender,

participatory approaches) and justice dimensions (e.g., intergenerational) in shaping fair climate action.

- Define indicators, quality standards and criteria on how to account for justice and equity across different societal groups and sectors to formulate recommendations on how to better operationalize the justice concept in adaptation pathways.

The research should be conducted through close collaboration between European and international research teams, hence international cooperation is strongly encouraged. Moreover, involvement of key stakeholders and regional experts as part of an inclusive process is essential to guarantee that all relevant perspectives are adequately represented.

The projects funded under this call should envisage clustering activities with other relevant ongoing projects (in and outside of Horizon Europe) for cross-projects cooperation and exchange of results. All projects funded under this topic are strongly encouraged to connect, coordinate, and participate in networking, intercomparison and joint activities, as appropriate.

This topic is a Societal-Readiness pilot:

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.

- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related activities. Consortia should mobilise a variety of SSH research backgrounds, in particular equity, poverty, and gender experts.

HORIZON-CL5-2025-D1-08: Implementing the climate action pillar of the EU-African Union Climate Change and Sustainable Energy Partnership

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B.

	The following exceptions apply: At least 40% of the beneficiaries must be legal entities established in the African Union member states. Legal entities established in non-associated third countries are eligible to participate as beneficiaries.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Expected Outcome:

The action is intended to set the foundation for future collaborative activities between the African Union (AU) and the European Union (EU) on climate change research in the context of the implementation of the Partnership on Climate Change and Sustainable Energy (CCSE)[21] under the AU-EU High Level Policy Dialogue (HLPD) on Science, Technology, and Innovation[22] and its Innovation Agenda[23].

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

- Stakeholders, including funding entities, contribute more effectively to the implementation of the climate action pillar of the AU-EU CCSE Research and Innovation Partnership through an agreed strategy and reinforced R&I coordination.
- The R&I agendas and initiatives on climate issues relevant for Africa are better aligned and defragmented between the EU, national and multilateral levels. Impact of funding is enhanced.
- The climate data gap on Africa is reduced and AU countries are better able to access, utilise, and deploy state-of-art climate knowledge and services to inform decision-making and to accelerate a science-based implementation of the Paris Agreement, the Agenda 2030 on Sustainable Development as well as the AU Climate Change and Resilient Development Strategy and Action Plan (2022-2032).
- Impacts and risks of climate change are more accurately assessed, adaptation strategies developed, early warning systems deployed, strengthening climate and disaster resilience in AU countries in line with the objectives of the international dimension of the EU

[21] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/europe-world/international-cooperation/regional-dialogues-and-international-organisations/eu-africa-cooperation/partnership-climate-change-and-sustainable-energy-ccse_en

[22] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/europe-world/international-cooperation/regional-dialogues-and-international-organisations/eu-africa-cooperation_en

[23] https://research-and-innovation.ec.europa.eu/system/files/2023-07/ec_rtd_au-eu-innovation-agenda-final-version.pdf

Adaptation Strategy, the EU Disaster Resilience Goals, the Sendai Framework for Disaster Risk Reduction, the Nairobi Declaration and the Early Warnings for All initiative.

- AU researchers and scientific institutes engage more effectively in internationally funded research and are better included in multilateral collaboration networks, with positive effects on diversity and quality of climate science research and benefiting key international assessments (e.g., IPCC).

Scope:

African societies and productive sectors have already experienced widespread impacts from natural hazards and human induced climate change, including loss of lives and biodiversity, water shortages, ocean acidification, reduced food production and economic growth. The IPCC warns that with additional warming these risks will further escalate. Socioeconomic, political and other environmental factors such as high demographic pressure, violent conflicts, unsustainable land-use patterns, strong reliance on agriculture and natural resources, interact with climate change and further exacerbate the region's vulnerability, undermining its socio-economic advancements. Yet, the continent is very poorly equipped to deal with climate related challenges and natural disaster risks: for example, only 40% of its population has access to early warning systems – the lowest rate of any region of the world, and many countries lack quality climate data.

In addition, despite multiple efforts to promote climate research and capacity development, African scientists, scholars, and practitioners are still significantly underrepresented in international fora, such as the IPCC. Furthermore, the bulk of research concerning the region is performed by groups from the Global North, not sufficiently incorporating indigenous knowledge, local contexts and needs.

Given the strategic partnership on Climate Change and Sustainable Energy (CCSE) between the EU and the AU and the shared priority of combating climate change in both regions, there is a strong case for a strengthened and more coordinated R&I cooperation on climate change research. The collaboration should prioritise climate risk reduction and adaptation to develop a long-lasting R&I EU-AU partnership.

This action is intended as a preparatory step towards future joint collaborative activities between the EU, and the AU and their respective Member States to support the implementation of the "Climate Action for adaptation and mitigation" Pillar of the CCSE partnership. The action should therefore establish a joint strategy for improving the availability and accelerating the uptake of advanced climate knowledge, data, and products (including through Earth Observation) across Africa. The aim is to enhance climate literacy, to develop and increase uptake of climate services and early-warning systems, and to support capacity building while taking into consideration the continent's socio-economic circumstances and user needs. Therefore, it is expected to address all of the following aspects:

- Develop a joint roadmap identifying priorities, flagship actions and implementation architecture to pave the way towards more targeted EU-AU cooperation on climate change research, with particular focus on climate risk reduction, contributing to the implementation of the Climate Action pillar of the CCSE Partnership (to be delivered within the first year of the project);

- Mobilise and secure commitments from European and African national funding entities and other actors (e.g., philanthropies, international cooperation entities and financial institutions) necessary to implement joint EU-AU collaborative activities, including a potential Horizon Europe programme co-fund action in 2026-2027 (to be delivered within the first year of the project);

- Map the relevant EU, internationally and nationally funded projects (such as CONFER, FOCUS-Africa, DOWN2EARTH, ALBATROSS, SAFE4ALL, HABITABLE, TEMBO-Africa, SINCERE[24]), match their outputs with the objectives of the CCSE Partnership, and cluster them to establish a vibrant community. Develop and implement a strategy to consolidate, curate, valorise and disseminate the projects' outputs towards African stakeholders to amplify their impact;

- Design and start implementing training and capacity building strategy that should enable: i) effective climate action planning and management, ii) enhanced representation and diversity of African science and scientists in international fora, iii) advance generation of data, products, applications, services, and policy relevant knowledge on climate change, and iv) a greater participation of women, young youth and marginalized communities.

It should bring together core European and African funding agencies, research organisations and other key African organisations such as regional and national climate service centres. Strong representation of African partners in the consortium is a core requirement. In addition, the action should promote the uptake of indigenous knowledge and citizen science.

The action should build on establish synergies and aims at improving the coordination between existing multilateral and bilateral initiatives, such as the Climate Services for Risk Reduction in Africa (CS4RRA)[25], the ClimSA[26] programme, projects funded by the EU (Horizon 2020 and Horizon Europe) and the JPI-Climate (ERA4CS). Synergies should also be sought with other relevant activities of the World Climate Research Programme, the World Meteorological Organisation, the Group on Earth Observations, or the Copernicus programme. It is advisable that the action integrates the lessons learnt from the implementation of the energy pillar of the CCSE Partnership[27].

[24] Please refer to https://cordis.europa.eu/projects/en for more information
[25] http://cs4rra.wascal.org/
[26] https://www.climsa.org/
[27] See https://cordis.europa.eu/project/id/815264 and https://cordis.europa.eu/project/id/963530

Destination – Cross-sectoral solutions for the climate transition

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *"Facilitating a clean and sustainable transition of the energy and transport sectors towards climate neutrality through cross-cutting solutions*".

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, hydrogen[28], communities and cities[29] and others. 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.

The main impacts to be generated by topics under this Destination are:

Batteries

1. Increased competitiveness and strategic autonomy of EU Battery sector while maximizing sustainability.
2. Enhanced local and circular supply chains by reducing dependency on critical raw materials and upscaling processing capacity, also for recycled materials.
3. An integrated European battery sector for high performance batteries, from design to manufacturing and all the way to end of life, reducing environmental impact.
4. Improved resilience of EU energy system and facilitated integration of renewable energy sources through application of energy storage.
5. Affordable and reliable batteries to boost the market penetration of Electric Vehicles and storage systems.

Cities and Communities

To be added

[28] The bulk of activities are supported by the Institutional Partnership 'Clean Hydrogen'.

[29] 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.

Batteries

HORIZON-CL5-2025-D2-01: Development of Sustainable and Design-to-Cost Batteries with (Energy-)Efficient Manufacturing Processes and Based on Advanced and Safer Materials (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome:

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

- Reducing battery cost while lowering the share of Critical Raw Materials (CRM) [30] through better cell design and active material selection.
- Application of design-to-circularity strategies to reduce battery lifecycle costs.
- Improvement in safety and lifetime for mobility applications.
- Energy-efficient and environmentally sustainable production processes.

Scope:

Proposals should address technologies for design-to-cost batteries, with little reliance on CRMs, from one of the following two main categories:

[30] Reference to CRMA to be added in May after final adoption.

- Design-to-cost liquid-electrolyte lithium-ion battery advanced materials for mobility applications (e.g., LFP, LMFP, Mn-rich HLM);
- Sodium-ion battery materials for mobility and stationary applications.

In addition, the projects are expected to demonstrate improvements and adaptability of the developed materials with regards to one of the following cell production processes:

- Dry or aqueous processing technologies;
- Advanced electrode drying processes;
- Improved formation and aging protocols and methods to better monitor these production steps;
- Improved energy efficiency of dry rooms processes.

Furthermore, the projects are expected to present applicability of the samples to one of the following solutions toward design for circularity:

- Design for sorting, dismantling, separation, safe recycling (incl. direct recycling);
- Technologies to ensure maximal recovery of all battery materials whilst achieving a positive environmental profile vs primary production;
- Sensing solutions to improve lifetime and state of health detection;
- Identification of State-of-Health (SOH) parameters to determine the appropriate recycling method.

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-CL5-2025-D2-02: Cost-effective next-generation batteries for long-duration stationary storage (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions

Eligibility conditions	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).
Technology Readiness Level	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:

- Developing advanced battery materials aiming at storage duration from 12 hours to seasonal storage, which will facilitate reaching the renewable energy adoption targets set by REPowerEU.
- Minimize the use of Critical Raw Materials (CRM) in line with the EU's Critical Raw Materials Act [31] to enhance economic base, reduce dependencies and ensure competitiveness in green and digital transitions.
- Developing viable alternatives to the current state of the art battery technologies and to other seasonal storage devices in terms of cost, efficiency, safety, lifetime and (environmental) sustainability.
- High stability and low self-discharge rates to ensure the longevity of energy storage systems.
- Battery technologies with minimal temperature control, storage in a wide range of State-of-Charges (SOCs), and minimal voltage slippage.

Scope: This call aims to promote the development of materials that will work in relevant 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 materials.

The activity is focused on advancing technologies that are presently at an early or low Technology Readiness Level. Lithium-ion, Vanadium-based redox flow, sodium-ion, molten sodium-sulphur and other commercialised technologies are out of scope of this topic.

Projects are expected to contribute to improvement of materials:

[31] Reference to CRMA to be added in May after final adoption.

- Material cost < XX €/kWh;
- Minimizing the dependency on CRMs and targeting a specific share of European raw materials - i.e., materials that can be sourced in the EU or with a lower criticality / substituting strategic raw materials with non-strategic ones.

Furthermore, depending on the choice of battery chemistry/configuration, the following points must be addressed:

- Metal-air chemistries: reduction of sensitivity to impurities of gases;
- Multivalent chemistries: development of electrolytes with reduced corrosivity and improved compatibility with other cell components and housing;
- Materials for redox flow chemistries: development of eco-friendly and low-cost redox couples, without dependency on CRMs;
- Aqueous-based chemistries: development of active materials with improved, electrolyte formulations which extend the voltage window.

Proposals are invited to implement computational models and/or artificial intelligence methods for materials discovery/cell design.

All proposals are expected to cover prospects of circularity and manufacturability:

- High throughput processing;
- Technologies and processes for integration of sensing, self-healing, and smart functionalities to optimise storage and extend cycle life.

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-CL5-2025-D2-03-SRP: Sustainable processing and refining of raw materials to produce battery grade Li-ion battery materials (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	

Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: To increase EU resilience in raw materials supply chains and thus reduce the serious risk to the Union's strategic assets, economic and societal interests, autonomy and security associated with the current EU reliance on a few third countries for critical raw materials, by increasing sustainable and responsible sourcing of primary and secondary raw materials necessary to enable the green and digital transition and in alignment with the Communication (2020) 474 on Critical Raw Materials Resilience and the Critical Raw Materials Act, participation in this topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Member States*, MERCOSUR, CARIFORUM, Andean Community and countries with which the EU has concluded strategic partnerships on raw materials. The choice of these countries was made taking into consideration the development of strategic international partnerships on raw materials and avoidance of reinforcing existing over-dependencies, as well as the importance of involving partners committed to pursuing open trade in such materials. Proposals including legal entities which are not established in the countries that fall under the criteria above will be ineligible. *"African Union Member States" includes countries whose membership has been temporarily suspended. 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).
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome:

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

- Enhanced strategic autonomy for Europe in the battery raw materials sector, with a focus on creating new business models and opportunities within a strengthened battery value chain;

- Increased processing and refining of battery raw materials in the EU, particularly contributing to the benchmark of 40% of domestic processing capacity in the EU for Strategic Raw Materials.Demonstration of advanced, scalable technologies for the

processing of primary and secondary raw materials into high-quality battery metals/active materials, emphasising operational feasibility and sustainability;

- Significant increase in the sustainability, efficiency, and resilience of the European Li-ion battery sector by adopting innovative refining and processing solutions;
- Minimise environmental impact, reduce supply risk of raw materials, and support a circular economy;
- Further promotion of circular battery economy by expanding the refining capacities for secondary streams from recycled battery materials to enhance the value chain of battery recycling;
- Facilitate the implementation of sustainability and circularity objectives in the Batteries Regulation, specially mandates for minimum recycled content.
- Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake and building trust in results and outcomes.

Scope: Projects should involve advanced technologies that can cost-efficiently and sustainably convert primary/secondary sources into at least one of the following:

- battery-grade metal and precursors;
- electrode active materials.

Raw materials in the scope are lithium, cobalt, natural graphite, nickel, manganese, and phosphorus.

Proposals should detail processes that are economically viable, environmentally sustainable, and ready for large-scale adoption, using at least one of the following source materials:

- Primary sources: Refining of extracted raw materials, with processes tailored to resources coming from the EU (or Horizon Europe associated countries);
- Secondary sources: Mining waste, tailings, and sludges and slags (for Ni, Co, etc.); Intermediate products of end-of-life processes and manufacturing scraps ; Wastewater from processing.

Exploration, extraction, and recycling processes are out of scope of this topic. The use of waste batteries and battery manufacturing waste which require (pre-)treatment is also out of scope.

Integration of produced electrode materials into cell production is out of scope, but validation of functionality and quality of the processed materials is within the scope.

This topic is a Societal-Readiness pilot:

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.

- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related activities."

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-CL5-2025-D2-04: Integrating advanced material, cell design and manufacturing development for high-performance batteries aimed at mobility (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	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:

- Supporting European battery cell manufacturers in their transition from incumbent (Gen3) lithium-ion battery to high performance (solid-state) batteries.

- Increasing diversity of chemistries, cell design (application-oriented) of the existing production lines and enabling European Original Equipment Manufacturers (OEMs) to stay competitive.

- Targeting (in mid-term) scaled production for premium products (for specific applications) toward EV-grade products and high production scale in longer term.

Scope:

Projects are expected to cover all of the following aspects:

- Development of new production processes, machinery and equipment for cost-efficiency, high throughput, and energy-efficiency;

- Development of novel cell designs for accelerated integration of solid electrolyte to the formats tailored to EV integrations;

- Development of advanced materials both in terms of materials developments and also electrolyte and anode production (extrusion, electrolyte).

Furthermore, one or more of the following points are expected to be addressed:

- Digitalization of control and processes:

    - Novel control technologies embedding executable digital twins (virtual sensing, virtual condition monitoring, predictors…), sensing, etc.

- Development of multiscale models targeting advanced materials, new cell designs, and flexible manufacturing routes;

- Elements of sustainable production, and design for circularity: 9R framework on circularity and safe and sustainable by design framework.

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-CL5-2025-D2-05: Accelerated multi-physical and virtual testing for battery aging, reliability, and safety evaluation (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per	

project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B.

NOTE: This topic is a re-publication from WP 2024, when it was postponed. The text is largely unchanged.

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

- Shortening the development time of battery cells and battery systems by minimising the experimental testing effort and thus reducing the overall costs and time in battery system development and reducing the time to market;
- Increasing the battery reliability and safety through better understanding of the ageing, reliability and safety-relevant mechanisms and phenomena;
- Supporting the uptake of zero emission vehicles and the deployment of stationary energy storage systems (ESS) through safer and cost-effective battery systems;
- Fostering innovations in the eco-system battery through accelerated and more reliable verification and validation of advanced solutions contributing to increased user acceptability (safety & costs) and competitiveness of the European battery value chain;
- Standardisation of battery system testing & validation approaches focussing on the fusion of physical and virtual test methodologies.

Scope:

This call aims to reduce the development cost and time to market of battery systems by accelerated multi-physical and virtual testing. Current test strategies are still very time consuming and costly due to the need to understand the impact of multi-physical operational

loads (electric, thermal, mechanical, …), potential failure modes, ageing and misuse on the safety and reliability of battery cells, modules, and systems level. For overcoming these barriers, new multi-physical test strategies supplemented by virtual testing are required deepening the understanding of factors impacting ageing, reliability and safety and their dependencies.

This call complements the previous call HORIZON-CL5-2022-D2-01-07 focusing on the digitisation of battery testing. To differentiate, research activities should focus on the orchestration of accelerated testing and should result in a coherent test strategy from cell to system as much as possible independent from chemistries and technologies applicable also to next-generation batteries. Proposals can address mobile as well as stationary applications and should address and demonstrate all following activities:

- Understanding and describing the impact of multi-physical operational loads, failure modes, ageing and misuse on battery reliability and safety highlighting the dependencies between them in order to design the most adequate testing methods and parameters. This includes deeper understanding of ageing and degradation mechanisms induced by accelerated tests both on batteries safety performance and cycle-life to optimise the testing strategy.

- Deriving advanced operating profiles for testing and development of novel X-in-the-Loop (XiL) test environments for multi-physical and accelerated testing addressing electrical, thermal, and mechanical loads at the same time. This includes the design of specimen mountings representing real-life conditions.

- Combining physics-based with data-driven test strategies enabling reliable virtual and distributed battery testing from cell to system taking into account specific applications. This includes developing methodologies for accelerated model convergence mixing digital and XiL test results as well as of decision-making algorithms for automated test definition and execution.

- Development of simplified test strategies reducing the number of test and their complexity while improving battery safety and reliability. This includes on the fly testing protocols to facilitate/accelerate the parametrisation as well as the testing of aged or damaged batteries. Synergies between different battery chemistry, including next generation battery designs and sizes should be exploited allowing to re-use or scale test results from cell to system level.

- Research activities should also lead to advance response strategies for damaged and aged batteries as well as should contribute to a European-wide safety classification system for safety. For the latter, the development of concepts for such a safety classification system are being expected.

Activities could be complemented by following aspects:

- Development of virtual methods to reduce the complexity of testing sample to sub-system DUTs (device under test) while full system is validated by virtual methods using the results from physical sub-system test,

- Development, exploitation, and harmonisation of advanced battery cell/pack measurement & diagnostic methods for enhancing the data depth and breadth over what is currently available. Development of performance indicators relating to battery degradation and safety and methods / requirements for correlating / validating digital models,

- Application of AI to the collected data at laboratory to redefine designed test matrix in order to improve the potential conclusions, to reduce the testing time and effort and in general, to enhance the applied testing methodology.

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).

To strengthen European battery production ecosystem, projects are encouraged to implement batteries produced in EU Member States/Associated countries at large or pilot plant scale.

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-CL5-2025-D2-06: Battery Technology and Innovation Platform and Information Observatory (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Action
Eligibility conditions	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).
Technology Readiness Level	

Expected Outcome:

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

- An information observatory which is easily accessible for European battery R&I stakeholders, and which contains up to date information on the state of battery R&I in Europe, and insights into the state of battery R&I in other countries where a relevant battery value chain exists.

  A solid basis of information which will inform decision making within the European battery value chain, on European, national, and regional levels, and for public and private actors alike.

- An agile European battery value chain that can update its priorities based on global trends.

Scope:

The project proposal should cover all of the following tasks:

- Creating a durable online accessible platform which:
  - Provides a rolling assessment of the current state of art of battery technology, both globally and in Europe;
  - Provides an updated set of technical targets and intermediary KPIs to track the progress of the battery technology in Europe;
  - Providing a rolling overview of ongoing research and innovation projects on batteries in Europe. Not only from the BATT4EU Partnership projects, but also funded by other European funding mechanisms (i.e., a project map);
  - Providing a rolling overview of funding opportunities for battery R&I in Europe (i.e., a funding map).
- Collaborating with HORIZON-CL5-2025-D2-07 to track the technical progress of the BATT4EU projects and other European-funded battery projects to assess progress towards
  - the objectives of the BATT4EU Partnership;
  - progress towards the objectives that are part of the updated SET-plan;

- progression of the current state of art.

- When asked, supporting monitoring efforts undertaken by the European Commission, the EBA or other European initiatives regarding concrete indicators of industrial progress in Europe.

- Providing an analysis of battery roadmaps from other global regions and see how they compare to the state-of-art and targets set for the European battery technology development and proposing updates to the European battery R&I strategy in a yearly report, both for short-, medium- and long-term research needs.

Projects are encouraged to integrate nationally and regionally funded projects and funding schemes in the projects and funding map, respectively.

For the above activities, stakeholder consultations are expected to be held. Utilising the Working Groups and Task Forces established under the BATT4EU Partnership is preferred, but other ad hoc consultations could be accommodated. No permanent set of stakeholder groups is foreseen under this call.

To ensure continuity into FP10, 4-year project duration is expected.

HORIZON-CL5-2025-D2-07: Fostering an Excellent Battery R&I Community for Better Projects and Innovation Uptake (Batt4EU Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Action
Eligibility conditions	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).
Technology Readiness Level	

Expected Outcome:

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

- Fostering the scientific, technological, economic, and societal impact of the BATT4EU Partnership and its projects and paving the way to industrial exploitation of their research results in key energy and transport application domains.
- A well-coordinated, best-in-the-world, battery research community in Europe, gathering excellent scientists and innovators as well as involving other relevant stakeholders.
- Spreading of excellence in future battery technologies across Europe, including the exchange of best practices.
- Scientific monitoring of the BATT4EU project results to support the development of future research calls and identify promising technologies for upscaling.

Scope:

To ensure that the EU-funded projects contribute to the BATT4EU objective of creating the best battery innovation ecosystem in the world in Europe, all of the following actions need to covered by the project proposals:

- Organise and support clustering events to ensure that projects working on similar topics can learn from each other's results;
- Organise and support workshops for the community that will improve the overall knowledge level of the sector;
- Share best practices with the community and push for adoption of common data standards and reporting methodologies;
- Organise a yearly conference where BATT4EU projects can share their results and support high-level events co-organised by the Partnership where researchers, industrial developers and policy makers meet to discuss the most pressing research needs;
- Compare the European battery innovation ecosystem to ecosystems elsewhere in the world and draft recommendations for organisational improvement.

To ensure that results of the projects under the BATT4EU Partnership project find their way to the market or to the right funding mechanism to take the next step, all of the following actions need to be covered by the project proposals:

- Informing Partnership projects on the possibilities on funding mechanisms to take their developed technologies to the next level;

- Support Batt4EU projects in an early stage to get training and mentoring on how to best exploit the ideas coming out of their projects, especially on areas like intellectual property (IP) management and the development of viable business cases;

- Support EU initiatives, like the EU-Norway strategic partnership on sustainable land-based raw materials and battery value chains[32], the EBA, the IPCEIs and the EITs InnoEnergy, Raw Materials and Manufacturing to create research-to-business matchmaking events between projects looking to upscale innovations and possible upscaling partners and investors.

To ensure continuity into FP10, 4-year project duration is expected.

Placeholder: Joint topic with India on recycling of EV batteries

[To be further developed]

Cities and communities

HORIZON-CL5-2025-D2-08: Driving Urban Transition Co-funded Partnership

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Programme Co-fund Action
Eligibility conditions	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 proposal must be submitted by the coordinator of the consortium funded under HORIZON-CL5-2021-D2-01-16: Co-Funded Partnership:

[32] https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1654
https://ec.europa.eu/docsroom/documents/58658

	Driving Urban Transitions to a sustainable future (DUT). This eligibility condition is without prejudice to the possibility to include additional partners.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The evaluation committee will be composed partially by representatives of EU institutions. 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.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: 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. For the additional activities covered by this action: • The funding rate is 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 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. 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).

Total indicative budget	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/envisioned 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.

Cross-cutting issues

HORIZON-CL5-2025-D2-09-SRP: Monitoring, Coordination and Evaluation of the Societal Readiness Pilot

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Actions
Legal and financial set-up of the Grant Agreements	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)[33].

[33] 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

Expected outcome:

Societal Readiness is a characteristic of R&I results, indicating they have accounted for different societal needs and concerns, thereby increasing its potential for societal uptake. The action will accompany projects subject to the Societal Readiness pilot within Cluster 5 work programme to develop and apply the societal readiness concept during the project implementation.

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

- Research and innovation communities focusing on Societal Readiness consideration in the field of climate, energy and mobility are equipped with a sound, proven and replicable methodological approach to address Societal Readiness in future EU projects;
- A targeted strategy for intensifying collaboration between Scientific, Technical, Engineering and Mathematical (STEM) and Societal Sciences has led to in-depth interdisciplinary work;
- Dedicated outreach and coordination activities (e.g., facilitation processes and dissemination of best practices and challenges) have produced a strong European network of project partners and stakeholders to exchange experiences on the Societal Readiness pilot;
- Project recommendations contribute to more impactful R&I, which is driven by the needs, values, and expectations of diverse social groups, inclusive and transparent in processes and outcomes and active in identifying, mitigating, and avoiding negative/providing positive social, environmental, and economic externalities. They are actionable and supported by a clear and practical way forward for the implementation of the Societal Readiness approach in the context of Horizon Europe projects;
- Training resources provided to research and innovation communities are based on experimental data and broad literature review and is supported by the analysis of other external Societal Readiness experiences.

Scope:

The integration of the Societal Readiness approach is piloted in six topics from the Cluster 5 work programme 2025: [*LIST OF TOPIC CODES*]. Requirements applying to pilot topics are located at the end of the introduction of this work programme; related definitions are in the Horizon Programme Guide.

Due to the experimental aspect of the Societal Readiness pilot, it is necessary to closely monitor pilot projects at each stage of their implementation, foster cooperation and coordination between selected pilot projects and eventually draw recommendations on the way forward.

Therefore, proposals should perform the following actions:

- Monitoring: Closely follow-up how selected pilot projects address Societal Readiness issues, identify challenges they encounter; compare operational implementation methods across pilot projects; identify a common set of concerns across pilot projects.

- Coordination: Provide to pilot projects the opportunity to report on their experiences and facilitate the exchange of experiences and best practices so that it brings added value to on-going activities, constructively challenging the projects where necessary. Set up a safe space to exchange on less successful experiences. In addition, workshops to foster cooperation and exchanges should be organised.

- Support to applicants: Contribute to complete the set of training resources initiated by the Commission by providing directions, good practices, illustrative examples, advice and useful links to help applicants in applying Societal Readiness to their project.

- Recommendations: Learning from the outcomes collected on this Societal Readiness experiment, reflect upon successes, and needed improvements, and propose coordinated, balanced, and coherent recommendations to bring the Societal Readiness pilot forward. In view of informing FP10, intermediate recommendations should be provided to the European Commission mid-way.

A duration of four years is recommended for this action, to allow a maximum coverage of the selected pilot projects.

This topic requires the effective contribution of relevant SSH expertise, including the involvement of SSH experts and/or partner organisations, to meaningfully support the monitoring, coordination, and evaluation of the Societal Readiness pilot.

Placeholder: Joint topic with India on waste to renewable hydrogen

[To be further developed]

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).

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *'Ensuring more sustainable, secure and competitive energy supply through solutions for smart energy systems based on renewable energy solutions'*.

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

The main impacts to be generated by topics under this Destination are:

Renewable energy

1. Energy producers have access to competitive European renewable energy and renewable fuel technologies and deploy them to enhance the EU's energy security. This will contribute to the 2030 "Fit for 55" targets (in particular, at least 42.5% renewable energy share and aiming for 45% in the EU energy consumption, 5.5% advanced biofuels and renewable fuels of non-biological origin share in EU fuel consumption). It will also contribute to the indicative target of at least 5% innovative renewable energy technology for the newly installed renewable energy capacity. By 2050, climate neutrality in the energy sector will be achieved in a sustainable way in environmental (e.g., biodiversity, multiple uses of land and water, natural resources, pollution) and socioeconomic terms, and in line with the Sustainable Development Goals.

2. Technology providers have access to European, reliable, sustainable, and affordable value chains of renewable energy and renewable fuel technologies.

3. Economic sectors benefit from better integration of renewable energy and renewable fuel-based solutions that are among others cost-effective, efficient, flexible, reliable, and sustainable. Such integration is facilitated by digital technologies and by renewable energy technologies that provide network stability and reliability.

4. European researchers benefit from a stronger community and from a reinforced scientific basis on renewable energy and renewable fuel technologies, also through international collaborations.

5. European industries benefit from a reinforced export potential of renewable energy and renewable fuel technologies, also through international collaborations.

6. European industries become frontrunners and maintain technological leadership in innovative renewable energy technologies in line with the energy union strategy.

7. European citizens have access to an energy market that is fair and equitable, more resilient, uses all different types of local renewable energy resources, and is less dependent on fossil fuels imports. Local communities benefit from a more decentralised and secure energy system and from multiple uses of land and water. Less citizens experience fuel and energy poverty.

8. The Strategic Energy Technology Plan (SET Plan) implementation working groups on solar photovoltaics, solar thermal technologies, renewable fuels and bioenergy, wind energy, geothermal energy, and ocean energy benefit from a reinforced scientific basis and collaboration on renewable energy and renewable fuel technologies towards meeting the ambitious targets of the European Green Deal.

Energy systems, grids & storage

R&I actions will support the just digital and green transformation of the energy system through advanced solutions for accelerating the energy systems integration and decarbonisation. The developed clean, sustainable solutions will contribute to making the energy system and supply more reliable, resilient, and secure. The solutions will contribute to increase flexibility and grid hosting capacity for renewables through optimizing cross sector integration and grid scale storage. They will enhance the competitiveness of the European value chain, reduce pressure on resources (also by making technologies 'circular by design') and decrease dependencies.

Innovative and cost-effective energy storage (integration) solutions are developed, that provide flexibility to the energy system, reduce total cost of grid operation and enhancement and that minimise the use of critical raw materials and ensure, to the best extent possible, their reuse and recycling, are key elements of the energy system.

Carbon capture, use and storage (CCUS) and carbon dioxide removal (CDR)

1. Accelerated development of carbon capture, use and storage (CCUS) as a CO_2 emission mitigation option in electricity generation, in industry applications and carbon dioxide removal technologies (including conversion of CO_2 to products).

2. Reduced EU's dependency on imported fossil fuels and increased energy security, reduced energy system's vulnerability to the impacts of the changing climate.

Global leadership in renewable energy

Global leadership in renewable energy

HORIZON-CL5-2025-ñ: Large-scale production of liquid advanced biofuels and renewable fuels of non-biological origin

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome: A quite wide portfolio of technologies are ready to be deployed, but still lack the real-world demonstration of economic viability. Significant volumes of advanced biofuels and renewable fuels of non-biological origin (RFNBOs) are needed to cover the current fleets, and the sectors where renewable fuels are the main long-term solution such as aviation, shipping, and energy intensive industries. Therefore, an exceptional effort is needed to establish more successful projects where full-scale plants are built and operated based on the vast potential of sustainable feedstocks throughout the EU.

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

- Mobilise industrial capacity for advanced biofuels and renewable fuels of non-biological origin to the benefit of energy producers and consumers;
- Support first-of-a-kind plants of advanced biofuels and renewable fuels of non-biological origin to act as precursors for the following commercial plants to the benefit of technology developers;

- De-risk the innovative technologies, reduce CAPEX and production costs and boost scale-up of advanced biofuels and renewable fuels of non-biological origin and contribute to their market up-take to benefit technology providers;

- Improve the sustainability, reliability, robustness, and security of the relevant value chain to the benefit of public authorities, citizens, researchers, and industrial stakeholders;

- Provide evidence to national authorities for innovative advanced biofuels and renewable fuels of non-biological origin technologies that can contribute to the Renewable Energy Directive indicative target for innovative renewable energy technology in each Member State of at least 5 % of newly installed renewable energy capacity by 2030. Provide factual information and evidence to policy makers and regulators in view of their decision as regards accelerating permitting procedures, harvesting benefits from multiple uses of land and water and increasing the responsiveness of research and innovation in that field to diverse societal interests and concerns;

- Support and facilitate the implementation of the Strategic Energy Technology Plan (SET Plan) Action for Renewable Fuels and Bioenergy.

Scope: Demonstration of innovative large-scale production of liquid advanced biofuels and renewable fuels of non-biological origin for sectors with specific need for such fuels. Production will be based on various EU sustainable biomass feedstocks, notably biogenic residues and wastes, and on non-biological origin feedstocks, such as renewable hydrogen and CO_2 or renewable carbon, nitrogen, or their compounds, through chemical, biochemical, biological, and thermochemical pathways, or a combination of them. Proposals will demonstrate large scale production of ready to deploy advanced biofuels and renewable fuels of non-biological origin, engaging feedstock developers and suppliers, technology developers, fuel suppliers, end users for purchasing the quantities, national bodies, and public or private authorities with funding capacity. Proposals will address and assess the impact of actual, real-size feedstocks, (like for example agricultural wastes, energy crops grown on marginal and degraded lands or as intermediate crops, forestry wastes, biogenic municipal and industrial wastes, all types of renewable hydrogen, actual streams of CO_2 and nitrogen, available renewable carbon or their compounds), in terms of their constitution on plant design, (e.g. for feedstock pretreatment and wastewater treatment as appropriate). They will also address and assess the impact on plant design and feasibility of improving the feedstocks externally and upstream to the fuel production plant, by increasing the energy density of the feedstocks through for example torrefaction, by homogenisation of feedstocks for making them uniform or similar, and by standardisation of feedstocks, as appropriate. Large-scale production of renewable hydrogen as an end-product is excluded from the scope of this topic.

The proposals will result in building and operating full-scale plants of advanced biofuels and renewable fuels of non-biological origin. The plan for the exploitation and dissemination of results should include a strong investment and business case and sound exploitation strategy.

The exploitation plan should include plans for scalability, commercialisation, and deployment It will provide information and assessment about the economic viability of the commercial plant, the permitting procedures, a full value chain-based business plan and identified funding sources such as, private equity, loans, loans guarantee, grants, or public financing for CAPEX and OPEX, as well as take-off agreements for the fuel uptake. Moreover, they will make use of the identified funding sources, like private equity, the InvestEU, the EU Catalyst Partnership, the Innovation Fund, and possibly the Regional Development policy funds. Projects must include at least one relevant local economic business case, outlining local value and supply chains and the expected number of local jobs at the place of deployment. Furthermore, proposals will provide information and assessment of impact to land and water uses, soil and biodiversity for example in relation to marginal and degraded land feedstocks, and of public awareness on full-scale renewable fuel plants.

An assessment of the sustainability and the GHG reduction from fossil equivalents should be shown based on a life-cycle analysis for the large-scale fuel production. Special attention should be paid to estimating the GHG emissions reduction potential; projects will be encouraged to use the methodology in the Innovation Fund.

HORIZON-CL5-2025-D3-02: Competitiveness, energy security and integration aspects of advanced biofuels and renewable fuels of non-biological origin value chains

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The EU energy security and industrial competitiveness are contested by the geopolitical circumstances and market situations around the world. Advanced biofuels and renewable fuels of non-biological origin are in EU's portfolio of technologies that contribute to net-zero manufacturing in Europe. However, remaining challenges impacting the security of supply and competitiveness of these technologies and the integration of their value chains need to be clearly understood, presented, and mitigated.

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

- Contribution to the EU energy security and industrial competitiveness of renewable fuel technologies to the benefit of energy consumers.
- Generation of benefits to energy producers and consumers of improved reliability, robustness and security of renewable fuel technologies compared to existing ones.
- Enhancing common knowledge and understanding about existing opportunities among diverse stakeholders (e.g., policy makers, public authorities, citizens, researchers, and industry) of integrated value chains for advanced biofuels and renewable fuels of non-biological origin.
- Generation of multi stakeholders' benefits, e.g., for policy makers, technology developers, researchers, and industrial stakeholders, of promoting sustainable development and sustainable agriculture regarding climate change resilience and regenerative practices, accelerating renewable fuel innovation, and maximizing carbon removals.

Scope: Proposals will assess the energy security and industrial competitiveness aspects of value chains for advanced biofuels and renewable fuels of non-biological origin, in view of the new situation in Europe regarding energy security and industrial competitiveness with the rest of the word. They will also evaluate how these technologies could contribute to the EU's energy security and industrial competitiveness through detailed value chain analysis and development of future scenarios, macroeconomic modeling, and strategic decision-making methods. Value chains closer to commercialization with the potential to contribute more to the EU 2030 targets for green transition and industrial competitiveness and value chains for technologies under development with the potential to contribute to the longer term and could duly adopt mitigation measures, are both in scope. Proposals will identify the research and innovation actions needed to improve the energy security and industrial competitiveness aspects of these value chains.

Integration challenges of the various steps in a value chain and of the relevant stakeholders will be addressed. Proposals will coordinate efforts towards development of win-win integrated solutions of sustainable value chains for advanced biofuels and renewable fuels of non-biological origin engaging all relevant stakeholders, including farmers, CO_2 suppliers, technology providers, researchers, fuel producers, end users, policy makers, international organizations. Multidisciplinary issues related to advanced biofuels and renewable fuels of non-biological origin production, carbon removals, CO_2 trading and valorization, sustainable

farming, production of nature-based soil amendments, fertilizers, and organic materials, will be considered, to achieve benefits for all through the integration.

Value chains of renewable hydrogen as an end-product are excluded from the scope of this topic.

A sustainability assessment of integrated solutions including technoeconomic, environmental and social aspects will be carried out based on life cycle analysis.

HORIZON-CL5-2025-D3-03: Novel approaches to geothermal resources development

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions.
Award criteria	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).
Technology Readiness level	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:

- De-risking and cost reduction of shallow and/or deep geothermal systems to the benefit of developers;
- Reduction of LCOE approaching SET Plan targets (actions should clearly justify estimated LCOE at project start and end) to the benefit of geothermal energy providers;
- Energy efficient, sustainable, socially accepted, environmentally sound, and economically viable generation of electricity, and/or heating and cooling from geothermal resources in a wide range of geological settings to the benefit of citizens;

- Increase technology leadership, competitiveness, and technology export potential of European industry in the geothermal energy supply chain.

Scope:

Drilling and subsurface engineering account for a large part of the costs of geothermal projects. Upfront cost reduction and performance improvement for new developments can boost the geothermal capacity deployment rate.

The scope covers advances beyond the state of the art in:

- Drilling and completion of wells;
- Enhanced design and subsurface engineering.

Proposals can address robot and AI assisted drilling, optimisation of the penetration rate, advanced drilling fluids, new materials for casing, cementing and completion, advances in monitoring, logging while drilling and geosteering high temperature electronics, well architecture and stimulation, closed loop technology and enhanced production pumps.

Proposals can aim at reducing development time and costs, adaptation to specific geothermal environments, standardisation of the drilling equipment enhanced well production, enhanced environmental performance, improve component resistance to corrosion, scaling, high temperature, wear, and mechanical failures, increase energy extraction.

Environmental impact of the proposal should be assessed, and mitigation measures considered in accordance with the DNSH principle.

Proposals are expected to include activities to foster citizen engagement and increase the responsiveness of geothermal energy to diverse societal interests and concerns.

HORIZON-CL5-2025-D3-04-SRP: Development of hydropower technologies and/or water management schemes allowing for win-win situation of flexible hydropower and biodiversity improvement

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome:

For a renewables-based electricity system sufficient flexible and also in the long-run highly sustainable hydropower capacity is pivotal.

Project results are expected to contribute to all of the following expected outcomes, from which current and future hydropower operators and the hydropower technology provider industry will benefit:

- Enhancing the capacities of the hydropower fleet to contribute with renewables base load to a flexible energy system;
- Increase technology leadership, competitiveness, and technology export potential of European hydropower industry;
- Enhanced sustainability of run-of-the river hydropower through the setup of water flows in hydro installations, with positive effects on river ecosystems and biodiversity.
- Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake and building trust in results and outcomes.

Scope:

Development of hydropower technology and/or improved water management schemes, which allow for synergies between flexible hydropower energy generation and local ecosystem and management for existing run-of-river hydropower plants or cascades of such plants, by addressing issues such as hydropeaking, flood plein biotopes, sediment transport and/or river morphology restoration and efficient water flows also considering effects of climate change. Developed solutions shall enhance the flexibility of hydropower generation according to current and expected power grid needs, water availability, while being highly sustainable and creating positive impacts on river ecosystems and biodiversity. Specific issues for the hydropower generation efficiency and equipment functionality arising from this win-win optimisation should be addressed.

This topic is a Societal-Readiness pilot:

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.
- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related activities.

HORIZON-CL5-2025-D3-05: Demonstration of thermal energy storage solutions for solar thermal plants.

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.
Procedure	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 (and subject to available budget). This condition to ensure a balanced portfolio will also be considered to be met if a proposal addressing both areas is funded.

Expected Outcome:

Project results are expected to contribute to some of the following expected outcomes:

- Technology providers profit from successful demonstration and de-risking of thermal energy storage solutions that improve the dispatchability of solar thermal plants;

- Technology providers have improved access to financing through better understanding of the bankability of dispatchable solar thermal solutions;
- Electricity grid operators have access to reliable options to support the increase in the share of variable-output renewables and the reduction of curtailments;
- The execution of the solar thermal implementation plan of the Strategic Energy Technology Plan (SET Plan) is supported and facilitated.

Scope: Support will be given to the demonstration of innovative thermal energy storage solutions in the following areas: (i) concentrated solar power (CSP) and/or (ii) solar thermal heat and/or cold.

The proposed solutions will have to achieve substantial improvements in terms of performance, cost-effectiveness and life span compared to the current state of the art.

The project must include a clear go/no-go milestone ahead of entering the demonstration phase. Before this go/no-go milestone, the project must deliver the detailed engineering plans, a techno-economic assessment, and all needed permits for the demonstrator. The project proposal is expected to present a clear and convincing pathway and timeline to obtaining the permits.

Projects must assess the sustainability of the proposed solutions in environmental and socio-economic terms.

Where applicable, the demonstration must cover a continuous interval of at least six months covering all possible incidence angles of the direct solar radiation.

HORIZON-CL5-2025-D3-06: Innovative manufacturing of wind energy technologies

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	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:

- Energy consumers have access to affordable, clean, and secure energy with low negative environmental impacts;
- The wind energy supply chain strengthens their strategic autonomy, technology leadership, competitiveness, and technology export potential.

Scope: Proposals are expected to:

- Develop and demonstrate innovative manufacturing technologies that improve the health and safety working conditions along the supply chain;
- Develop and demonstrate innovative manufacturing technologies that allow for reduced energy and material consumption, increased circularity and lower costs;
- Develop and demonstrate automated and semi-automated manufacturing solutions that ensure high-quality products, increase the lifetime and the reliability of wind energy systems;
- Develop and demonstrate manufacturing solutions that allow for high production throughput, optimisation of logistics and transport of components and reduced impacts on the environment, cultural heritage, landscapes, and people.

The project could support the development of innovative manufacturing solutions for onshore and offshore wind energy production. It could focus on specific components of a wind energy system (e.g.: blades, nacelle and towers, gearboxes, foundations, generators, …)

The project must include a clear go/no-go decision ahead of entering the demonstration phase. Before this go/no-go moment, the project must deliver the detailed engineering plans, a techno-economic assessment, and all needed permits for the demonstrator. The project proposal is expected to present a clear and convincing pathway and timeline to obtaining the permits.

Projects must assess the sustainability of the proposed solutions in environmental and socio-economic terms.

Where applicable, the demonstration must cover a continuous interval of at least six months.

HORIZON-CL5-2025-D3-07: More reliable and easier to operate and maintain wind energy systems

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 4-6 by the end of the project – see General Annex B.

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

- Reduce the risks of different nature related to wind energy systems (operational, financial) and thus reduce the projects' uncertainties.
- The wind energy supply chain strengthens their strategic autonomy, technology leadership, competitiveness and technology export potential.

Scope: Proposals are expected to:

- Develop and validate solutions to increase the reliability of wind energy systems and their components;
- Develop new methods and tools to analyse and predict the reliability of wind energy systems, in light of the analysis of the failure modes of existing systems and including a focus on new technologies and materials;
- Develop new methods and tools for health monitoring of wind energy systems and their components;

- Develop and validate solutions to optimise the operation and maintenance of wind energy systems and their components.
- Develop innovative digital tools to facilitate wind farm operation and maintenance, for instance through improved interoperability and innovative sensors, while ensuring increased cybersecurity and data sharing.

The solutions proposed must provide solid data to support the choice of the sub-systems and components on which it is proposed to focus on. They should focus on the sub-systems and components that appear to be the most critical for the overall reliability of the wind energy systems, for instance, in the case of floating offshore wind, these could be dynamic cables and connection systems.

Digitalization plays a prominent role in the proposals under different perspectives, for instance in terms of improved predictive maintenance activities and advanced sensors technologies for diagnostics and structural health assessment and monitoring.

HORIZON-CL5-2025-D3-08: Understand and minimise the environmental impacts of wind energy

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	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).
Technology Readiness Level	Activities should include some testing and demonstrating activities and are expected to achieve TRL 4-6 by the end of the project – see General Annex B

Expected Outcome:

The Offshore Strategy[34] underlined that the deployment of offshore wind should be based on maritime spatial planning, assessing the economic, social and environmental sustainability of the installations, and ensuring co-existence with other activities. At the same time, it called for research on the cumulative impacts of offshore energy generation on the environment, which again was underlined in the Communication to deliver on the EU's offshore renewable energy ambitions, presented in October 2023[35].

Our knowledge on such impacts, positive and negative, is more advanced now that when the Offshore Strategy was adopted[36]. However, there are still significant data and knowledge gaps. Most fieldwork studies have been carried-out at very localised sites, and often focused on specific species. These ad-hoc studies lead therefore to conclusions that can be hardly generalised. A sound monitoring, measuring multiple pressures and impacts on ecosystems and their services, at wider scale and also in interaction with other sea activities, is still largely missing. There is also a need to further develop models and other instruments for environmental risk assessment mitigation and restoration measures, considering impacts during construction, operation and decommissioning.

Improving instruments, data and knowledge on the cumulative environmental impacts of offshore energy, as well as a sound monitoring, is key to ensure that its expected fast and large-scale deployment will be sustainable. It will also better equip the EU to contribute actions to mitigate such impacts and promote sustainable deployment of offshore wind at regional (e.g. through OSPAR in the Northeast Atlantic) or subregional (e.g. through the Greater North Sea basin Initiative) level.

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

- The scientific community, public authorities, project designers, and permitting authorities have better tools, data and knowledge to assess the cumulative environmental impacts of large-scale bottom-fixed and floating offshore wind energy generation, including at sea-basin level;

- Public and permitting authorities, offshore project designers, civil society organisations and citizens have more accessible and reliable knowledge, instruments and data on the (planned) cumulative impacts of projects, especially when combined with other planned or existing human activities;

- The monitoring of environmental impacts of offshore wind installations is improved, with better tools and open data;

[34] COM(2020) 741 final
[35] COM (2023) 668 final - EUR-Lex - 52023DC0668 - EN - EUR-Lex (europa.eu)
[36] See for instance the ETC/ICM Report 2/2022: Mapping potential environmental impacts of offshore renewable energy, at: https://www.eionet.europa.eu/etcs/etc-icm/products/etc-icm-reports/etc-icm-report-2-2022-mapping-potential-environmental-impacts-of-offshore-renewable-energy

- Ambitious national and regional offshore wind deployment targets are achieved with positive or minimum negative impacts on the marine and coastal environment;

- Project designers and technology providers, as well as public authorities and other stakeholders, have better knowledge of and access to tools and solutions to minimise the environmental impacts of offshore wind energy installations;

- Deploy offshore wind energy with minimal impact on marine and coastal ecosystems, and if possible with net-positive ones.

Scope: Proposals are expected to:

- Provide better knowledge and understanding of the cumulative environmental impacts of the offshore wind energy deployment according to the EU targets, when added to the current and planned human activities carried out in the same areas;

- Expand existing studies, monitoring and analysis from local to larger areas, and from site- or species-specific impacts to more general ones;

- Further develop and deploy monitoring activities, measuring multiple pressures and impacts on marine and coastal ecosystems and their services, as well as pollution, from installation to decommissioning and possible repowering, including operational phase and maintenance activities;

- Test and demonstration monitoring and modelling technologies, regarding environmental impacts of offshore renewable energy deployments;

- Improve instruments and models for Maritime Spatial Planning, and environmental assessments at plan and project level;

- Improve modelling capacity and environmental impact assessments of future offshore wind deployment;

- Support the identification of areas where wind energy deployment is particularly suitable without significant environmental impact and areas where, on the contrary, it should be avoided;

- Identify strategies, test and demonstrate technologies that avoid and mitigate the environmental impact of bottom-fixed and floating offshore wind energy systems, propose mitigation measures and if feasible, provide net-positive environmental impacts;

Synergies with other Horizon Europe projects, in particular those under the Mission Oceans like *Horizon-miss-2023-ocean-01-06* "Innovative nature-inclusive concepts to reconcile offshore renewables with ocean protection", should be ensured, as well as with the European Digital Twin of Ocean (European DTO) and its core infrastructure.

The projects funded under this topic should ideally cover, collectively, all the different European sea basin (Atlantic ocean, Baltic sea, Black sea, North sea and Mediterranean).

In addition to considering the most evident environmental impacts of offshore wind energy systems (displacement, collision, noise, habitat loss and degradation, …) the projects funded should include an analysis of possible new impacts, that may become particularly relevant when a high number of wind energy systems is deployed, for instance in relation to the presence of dynamic cables suspended in the water column or the production of microplastics.

HORIZON-CL5-2025-D3-09: Alternative Silicon Growth Technologies (from both liquid and gaseous phase) for PV Applications

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome:

The majority of commercially available PV solar cells produced worldwide are made of crystalline silicon. Material quality, process technologies, and solar cell architectures have improved significantly in recent decades, and solar cell efficiencies are now approaching 27%, thus close to the theoretical limit. However, challenges remain in several aspects, such as increasing the production yield, stability, reliability, cost, and sustainability.

The ingot and wafering production steps are power intensive and produce waste in the form of kerf slurry – the residue ingot material from between the sliced wafers. Those are the PV production steps most highly concentrated in China.

Project results are expected to contribute to all of the following expected 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 and components;

- Scaling-up solar PV manufacturing capacity in Europe for an accelerated solar PV deployment, supporting Europe's decarbonisation targets;

- Reduced energy and material consumption/lower carbon footprint for crystalline silicon PV products.

Scope:

Due to their efficiency, durability, crystalline silicon wafers are by far the most common absorber material used in the production of solar cells and modules today. These wafers are primarily made using either a directional solidification that produces large-grained multi-crystalline (mc-Si) wafers with a greater defect density or a solar-optimized Czochralski (Cz) growing method that produces crystalline silicon with low defect density (c-Si). In addition, "kerfless" silicon wafers can be grown directly either from molten silicon or from gaseous epitaxial deposition on a low-cost substrate at high temperature. To facilitate continued and rapid proliferation of Si photovoltaics, realizing new, more efficient and less energy and material intensive processes for silicon feedstock, ingots and wafers is seeked. Therefore, proposals are expected to:

- Demonstrate efficient processes or alternative methods to grow silicon ingots/wafers from both liquid and gaseous phase at lower cost (with lower energy requirements) compared to standard processes and possibly avoid the wafering step;

- optimise standard processes for defect and impurities minimisation, high-quality ingots with large diameters (for larger wafers) that allow for higher level of automation;

- involve multidisciplinary consortia including at least one silicon ingot/wafer manufacturer.

Proposals will present a plan for the exploitation and dissemination of results which should include a strong business case and sound exploitation strategy. 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-CL5-2025-D3-10: Towards commercialisation of Perovskite PV and development of dedicated manufacturing equipment

Specific conditions

Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome:

The rapid development of perovskite solar cells (PSCs) over the past decade makes it the most promising next generation photovoltaic technology, owing to its prominent advantages such as tunable bandgap, high absorption coefficients, uncomplicated preparation process and considerable power conversion efficiency which has reached a certified 26.1% at the cell level. Tremendous efforts in material and device engineering have also increased moisture, heat, and light-related stability. All these features render perovskite solar modules suitable for terawatt-scale energy production with a low levelized cost of electricity (LCOE). A number of companies are working on PSCs and some of them, have been establishing new pilot production lines and/or expanding production capacity. Still the greatest challenges toward commercialization are scaling up (including ambient manufacturing), achieving long-term stability, reducing, or eliminating the use of toxic solvents, and preventing Pb leakage into the environment.

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

- Increase stability, efficiency and minimise the environmental impact of Perovskite PV.
- Increase the potential for commercialisation of perovskite PV creating a competitive technological know-how for the European PV industrial base.
- Support 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 and components.

Scope:

Metal halide perovskite solar cells have attracted much attention because of their low-cost fabrication and high efficiency. Poor stability of these devices remains the key challenge in their path toward commercialization. To overcome this issue, a robust encapsulation

technique by employing suitable materials and structures with high barrier performance against the external environment must be developed to protect perovskite solar cells. Dedicated manufacturing processes and equipment need also be demonstrated. Therefore, proposals are expected to:

- Demonstrate effective strategies to enhance the optoelectronic properties, performance and stability of PSCs devices;
- scale-up reliable deposition of high-quality perovskite (PVK) films over large areas, (overcoming the degradation of efficiency as device/module areas scale up) but also patterning and interconnections to connect individual cells into modules;
- demonstrate internal and external encapsulation structures as protection from extrinsic environmental stressors, such as moisture, oxygen, heat, and illumination;
- control and manage the toxic Pb2+ waste that is produced by the irreversible deterioration of the perovskite materials;
- develop module designs considering recyclability requirements and restrictions;
- assess performance according to international standards and compared with well-established PV technologies;
- demonstrate suitable equipment adapted to the specific requirements of PSCs production process;
- involve multidisciplinary consortia including at least one PSC production or equipment manufacturer.

Proposals will present a plan for the exploitation and dissemination of results which should include a strong business case and sound exploitation strategy. 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-CL5-2025-D3-11: Novel inverter technologies and flexibility in PV systems

Specific conditions	
Expected EU contribution per project	
Indicative	

budget	
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to achieve TRL 5-7 by the end of the project – see General Annex B.

Expected Outcome:

Integrating renewable and distributed energy resources, such as photovoltaics (PV) and energy storage devices, into the electric distribution system requires advanced power electronics, or smart inverters, that can provide grid services such as voltage and frequency regulation, ride-through capabilities, dynamic current injection, and anti-islanding functionality. To enable this integration, designing novel smart inverter technologies, developing robust control algorithms for better inverter functionality, determining interactions between multiple smart inverters and between inverters and utility distribution systems, supporting standards development for smart inverter functionalities, and analysing the impacts of smart inverters on distribution systems is necessary.

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

- Energy yield improvement of PV systems based on smart digitalisation.
- Optimal utilisation of generated energy, energy savings, and enhanced overall energy efficiency.
- Enhanced demand side flexibility services.

Scope:

Proposals are expected to:

- Develop new inverter technologies with increased power density and reliability by introducing new wide bandgap semiconductors (GaN, SiC);
- design of smart inverter hardware and firmware;
- use of control and power hardware-in-the-loop techniques to determine interactions between multiple inverters at multiple points of common coupling;
- demonstrate integrated communication connection between inverters and other components (e.g., battery, PV modules, etc.) to automatically gather information

(serial number, geolocalisation, etc.) of components and support the automatic creation of Digital Twins and PV data models, towards a real predictive monitoring;

- evaluating system integration and cybersecurity, while providing guidance in future developments in both hardware and software.

HORIZON-CL5-2025-D3-12: Extending the lifetime of PV modules

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to achieve TRL 4-6 by the end of the project – see General Annex B.

Expected Outcome:

Photovoltaic (PV) energy systems are one of the cheapest and fastest growing sources of electricity generation, largely thanks to an important decrease in the cost of solar modules in the last 10-15 years, and to its simple installation. The PV market is changing fast, recently transitioning to high-efficiency c-Silicon cell concepts, larger modules or novel designs, use of new materials (e.g., anti-reflection and anti-soiling coatings, thinner glass, new encapsulants and backsheets), or increased number and topology of busbars or wires. There is no PV lifetime definition, but manufacturers usually guarantee a 25-year lifetime with an expected degradation rate of 0.8% per year. However, abnormal degradation rates are still reported for cell and module technologies due to a variety of failures which reduce reliability and increase the cost of PV systems operation.

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

- Reduced degradation to levels that enable longer PV module lifetimes.
- Increased module durability and reliability.
- Resource efficiency and lifelong energy yield improvement of PV systems.

- Levelised cost of electricity (LCOE) decrease.

Scope:

The degradation rate might vary depending on many factors such as material properties, environmental stress (solar irradiance, humidity, temperature, wind speed, dust, etc.), installation, design and type of components and connections, with some components deteriorating on their own and others impacting additional PV components, leading to more severe failures. To tackle these issues and extend the lifetime of PV modules (and systems) proposals are expected to:

- Identify failures encountered in recently developed high-efficiency or novel design c-silicon modules themselves and their components, exploring their mechanisms and root causes, reviewing each component's susceptibility to failures and impacting additional PV components;
- develop, where necessary, simple, applicable to most PV systems, cost-effective and accurate failure detection techniques;
- propose mitigation approaches at module and system level and validate approaches through modelling and lab testing;
- perform outdoor field experiments/testing.

Different locations representing the European range of climates to be considered for field experiments.

HORIZON-CL5-2025-D3-13: Precommercial Procurement programme for Wave Energy Research and Development

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Pre-Commercial Procurement/Public Procurement of Innovation (PCP/PPI)

Expected outcome:

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

- Energy producers and consumers benefit from improved efficiency and flexibility, reduced cost, improved reliability, robustness and security provided compared to existing wave energy technologies;

- Technology providers profit from accelerated technology development and successful demonstration and de-risking of wave energy with a view to their commercial exploitation;

- Wave energy technology providers have improved access to financing through better understanding of technological solutions, their bankability, and achieve more effective market uptake, business models, and commercialization avenues;

- Researchers, industry, public authorities, and citizens have access to increased knowledge, assessment methods and tools on the environmental (both positive and negative) impacts of the different renewable energy and renewable fuel technologies along their lifecycle and value chains;

- Wave energy technology providers have detailed analysis of current costs and potential future energy cost reduction pathways and the creation of a detailed business plan for full scale commercialisation;

- Funding authorities pool resources at national and EU levels dedicated to Research and Development and provide effectively a significant developmental boost of wave energy technology.

Scope:

The challenge is the development and demonstration of cost-effective wave energy converters that can survive in a harsh and unpredictable ocean environment through demand-driven Pre-Commercial Procurement. The challenge is open to proposals seeking to steer wave energy development in an effective way at a European level and to bring these technologies to the market.

The EuropeWave PCP action has introduced the ocean energy phase gate process on a European level procedure following the evaluation framework provided by Task 12 of the IEA Ocean Energy System Technology Collaboration Platform. It supported the development of several wave energy devices in a stage-gate process to Phase 3 (approximately TRL 6) and the scope of the action is to bring wave energy technologies to Phase 4 approximately TRL7/8) .

The proposed action is to be structured along the following phases:

Preparation phase: the participating users/buyers of R&D services (which can have a pan-European, national or regional focus) should agree on common performance levels and associated specifications for the wave energy systems.

The funding of the participating users/buyers and the European Union will be used to bring forward wave energy technologies and complete phase 4 (reach TRL7/8).

The results of phase 1 should lead to calls for tenders (for the procurement of R&D services) which focus on clearly identified technologies which contribute to the development of commercial wave energy devices.

The procurement should be open for developers, researcher organisations which are not located in the countries/regions of the participating users/buyers,

The procurement should be open to developers which completed phase 3 (with or without the support of WaveEurope). All developers should provide evidence that they have completed phase 3.

The expected outcomes at this stage: 1) completed tender documents, 2) signed joint procurement agreement confirming the collaboration modus including the financial commitment of the buyers group and 3) final confirmation of the lead procurer.

Execution stage: The action will take care for the implementation of the PCP/PPI and of the PCP/PPI contracts.

The results will be shared within the European industry to accelerate technology development and the establishment of guidelines and standards to facilitate the transferability of the knowledge creation. The research and specification work are expected tolead to at least 3 full scale demonstrators tested for at least 12-24 months in an industrially relevant environment during the action duration.

At the end of the action at least one of the demonstrators should be ready for testing in an operational environment at commercial scale. Proposals have to describe the jointly identified challenge, indicating how it fits into their mid-to-long term innovation plans, why solutions currently available on the market or under development are not meeting their needs.

Activities have to include: (1) networking related to preparation, management and coordination and (2) joint research activities related to the validation of PCP/PPI strategy. The consortium should have at least three legal entities established in different member states or Horizon Europe associated countries. In the consortium the participation of minimum two 'public procurers' is required. Other entities might be considered which can have a clear added value in the preparation and/or execution of the PCP/PPI or in coordination and networking activities.

HORIZON-CL5-2025-D3-14: Development of innovative solutions strengthening the security of renewable energy value chains

Specific conditions

Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.
Award criteria	The criteria are described in General Annex D. The following exceptions apply: No second project will be funded in each of the following energy security related value chain specificity areas, until not all other areas are funded: 1. Sustainability of renewable energy value chains 2. Skills for renewable energy value chains 3. Complexity for specific renewable energy value chains 4. CRM and circularity in renewable energy value chains (funding required)

Expected Outcome:

The security of Europe`s clean energy system will in the long-run benefit from research and innovation addressing energy-security relevant criticalities of the underlying clean energy technology value chains.

Project results are expected to contribute to at all of the following expected outcomes, from which all actors of European clean energy value chains can benefit:

- Strengthen the European Knowledge Base and research and industrial leadership on solutions for energy-security related aspects of renewable energy value chains;
- Develop technical and value chain solutions addressing key aspects improving the energy security of renewable energy technologies;
- Improve the competitiveness, sustainability, and resilience of European renewable energy value chains.

Scope:

In scope are novel solutions, which address in particular critical aspects affecting the energy security of specific renewable energy technologies and their value chains. Proposals should focus on development of solutions for these critical aspects, which can highly improve their

overall energy security performance in the European context in the long run. Project need to address all of the following points:

- Sustainability and social awareness of renewable energy value chains as a limiting factor for their roll-out and performance over time (hydropower, bioenergy/ others if funding);
- Skills for renewable energy value chain as a limiting factor for innovation and deployment;
- Complexity for specific renewable energy value chains (RFNBOs, solar fuels, if funding available: CCU and hydrogen);
- CRM and circularity in renewable energy value chains (additional funding required).

HORIZON-CL5-2025-D3-15: Building a Long-Term Africa-EU R&I on Sustainable Renewable Energies joint collaboration

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Action
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: In addition to the standard eligibility criteria, at least 40% of the partners must be from Africa Union member states. 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 EU intends to play an increasingly leading role in global/multilateral initiatives. The EU is developing further the AU-EU Research and Innovation Partnership on Climate Change and Sustainable Energy, emanating from the AU-EU High-level Policy

Dialogue ('Africa initiative'), to implement the AU-EU Innovation Agenda37 adopted in July 2023. The Green Deal underlines that "Renewable energy and energy efficiency, for example for clean cooking, are key to closing the energy access gap in Africa while delivering the required reduction in CO_2".

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

- The R&I communities of researchers, industries, funding organisations and policy makers have access to a long-term AU-EU sustainable R&I partnership framework to implement joint R&I programmes of activities;
- Researchers, industry, public authorities, and citizens have access to increased knowledge, assessment methods, tools and expertise network;
- The joint AU-EU Climate Change and Sustainable Energy Collaborative Partnership efforts will be strengthened, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.

Scope: The proposal will build on the achievements made under the project LEAP-RE to strengthen and establish a sustainable framework. The proposal will expand and provide support to the established community of researchers, industries, innovators; and funding organisations involved in the partnership, and seek to create links to other relevant R&I communities. Activities will contribute to human and institutional capacity-building and turn the EU-Africa R&I Partnership on Sustainable Energy into a long-term platform for collaboration.

The activities to be covered are:

- Support to the implementation of the AU-EU Innovation Agenda priority on Green Transition and will support the Global Gateway in Sub-Saharan Africa to increase investments in energy access. Activities will analyse the impact of relevant EU-Africa research and innovation projects funded by the EU in the sustainable energy domain.
- Accelerate the translation of innovation into real-life outputs.
- Engage local communities across the African continent, in view of facilitating co-design, hybridisation and accelerated adoption of innovation; social sciences and humanities are expected to play a key role.
- Develop human and institutional capacities, through the creation of a sustainable network of experts and knowledge for science-based policy-making on innovative sustainable energy in synergy with AU and EU initiatives.

[37] One of the flagship initiatives of the Global Gateway, which will in particular support the implementation of short-, mid- and long-term actions in the area of green transition related to climate change.

- Implement and push further clustering activities with ALL relevant on-going EU-funded projects, nationally and regionally funded projects to enable stronger cross-projects co-operation, consultations and joint activities on cross-cutting issues.
- Provide policy support to the Climate Change and Sustainable Energy collaborative action of the AU-EU High Level Policy Dialogue on Science, Technology and Innovation, and other AU-EU policy agendas.
- Update the strategic and joint research and innovation action roadmaps, implemented and defined in the project LEAP-RE, www.leap-re.eu, to the new ambitions for 2030 and 2050.

The future project is expected to run for at least five years to provide a long-term perspective and vision, in synergy with the new co-fund action (selected under the topic HORIZON-CL5-2024-D3-01-09).

HORIZON-CL5-2025-D3-16: Support to the SET Plan stakeholder fora

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Actions
Award criteria	The criteria are described in General Annex D. The following exceptions apply: Only up to one project will be funded in each of the following sectors: • geothermal energy • hydropower • ocean energy • photovoltaics • renewable fuels and bioenergy • solar thermal energy

	• renewable heating and cooling • direct solar fuels • wind energy • energy efficiency in buildings • carbon capture storage and use

Expected Outcome: Engagement of stakeholders is pivotal in the transition to a clean energy system and the achievement of the zero-emissions target.

Project results are expected to contribute to both of the following outcomes:

- Consolidation of strong and sustainable networks in the different technology areas covered through the Strategic Energy Technology (SET) Plan and its integrated roadmap.
- Cooperation among ETIPs and similar stakeholders' fora, support to existing SET Plan Implementation Plans and advancement towards more interconnected activities, both in terms of contents and implementation mechanisms.

Scope: In 2015, the launch of the Energy Union saw the SET Plan incorporated as the Energy Union's fifth pillar on 'Research, Innovation and Competitiveness'. With the 2023 Communication on the revision of the SET Plan, the strategic objectives of the SET Plan were harmonised with the European Green Deal, REPowerEU and the Net-Zero Industry Act.

Depending on the sector, European Technology and Innovation Platforms (ETIPs), and/or SET Plan Implementation Working Groups (IWG) and/or similar stakeholders fora support the development and implementation of the SET Plan R&I priorities by bringing together relevant stakeholders in key areas from industry, research organisations and, where applicable, SET Plan Countries' government representatives. They develop research and innovation agendas and roadmaps, industrial strategies, analysis of market opportunities and funding needs, understanding of innovation barriers and exploitation of research results, which are in line with the Recovery Plan for Europe and latest EU climate and energy related policies. They also provide consensus-based strategic advice to the SET Plan initiative covering technical and non-technological aspects.

Considering the overarching aim of the clean energy transition, ETIPs, IWGs and/or similar fora are encouraged to align and coordinate their activities, defining cross-cutting aspects for accelerating the clean energy transition and contribute to the development of a European Research Area in the field of Energy.

Proposals should support ETIPs and/or IWGs and/or stakeholders fora of one of the above-listed sectors, taking into consideration the specific needs of the sector they address and the

emerging policy priorities for their implementation as well as the coordination with other initiatives/projects, in order to avoid overlaps.

ETIPs, IWGs and stakeholders fora should ensure the participation of companies (industry and SMEs), research and civil society organisations, universities and European associations representing relevant sectors (as applicable) from a representative number of SET Plan countries establishing links with national authorities. To maximise their impact and widen participation, they are encouraged to develop and implement robust outreach approaches and societal engagement actions to span across the EU and associated countries**.**

Special attention should be given to the key challenges of the European Green Deal, including, but not limited to, technological pushback, industrial production, societal transformation, and just transition. Likewise, contributions to the goals of the European Research Area in the field of energy regarding how to incentivise investing in research and innovation should be addressed.

Furthermore, proposals should develop a dissemination and exploitation strategy and implement dissemination and networking activities with other existing ETIPs and IWGs (e.g., joint workshops, thematic conferences, webinar series, regular exchanges, etc.). Relevant outputs of these CSAs will feed into the SET Plan information system (SETIS).

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, to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Proposals should address one of the following sectors: geothermal energy, hydropower, ocean energy, photovoltaics, renewable fuels and bioenergy, solar thermal energy, renewable heating and cooling, wind energy, direct solar fuels, carbon capture storage and use, and energy efficiency in buildings.

Proposals submitted under this topic are encouraged to include actions designed to facilitate cooperation, across Europe, with other projects and to ensure the accessibility and reusability of data produced during the project. Proposals should include a finance and sustainability plan for future continuation beyond the lifetime of the proposal.

The indicative project duration is 3 years.

The requested budget for actions in the areas of _____ should be around _____ because in these sectors there is no ETIP, only a stakeholder forum with lighter structure and activities. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Energy systems, grids & storage

HORIZON-CL5-2025-D3-17: Control and operation tools for a RES-based energy system

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	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:

- Improved preparedness of the electricity system to support the EU's binding target for 2030 of minimum of 42.5% renewables in the gross final energy consumption, with the aspiration to reach 45%;
- Grid operators employ improved tools for forecasting energy generation from renewable sources and energy demand;
- Grid operators employ innovative energy management systems and technologies to operate efficiently the integration of RES at various voltage levels;
- Distribution system operators develop better capacity of exploiting system flexibility and accessing services for demand response and energy storage;
- System operators develop structured mechanisms to cooperate with energy suppliers and service providers when grid conditions requires it;
- Transmission and distribution system operators cooperate and develop mechanisms to reduce system risks associated with increased fluctuating generation.

Scope:

The projects will:

- design and test innovative technologies, processes and control mechanisms for the seamless integration of massive volumes of renewable energy sources (RES) at distribution and transmission levels;

- address network constraints and increase the flexibility capabilities of grids, through advanced operation and control mechanisms and tools, for improving the overall grid performance and the efficiency of RES uptake;

- ensure effective coordination between transmission and distribution levels of the electricity grids, for the integration of massive volumes of RES at multiple voltage levels, maintaining grid stability and overall preparing for a RES-based energy system;

- demonstration, test and validation of the activities in at least two pilots in different Member States/Associated Countries.

The proposals should demonstrate a clear understanding of the challenges and opportunities associated with integrating renewable energy sources into the existing energy system. Building on this, they should demonstrate a comprehensive approach for developing and testing advanced technologies and control mechanisms that can effectively address these challenges.

The proposals should take a system-wise perspective, also including control strategies which can effectively encompass the wide-area of interconnected electric systems.

Finally, the projects should propose a set of best practices and recommendations on the effective uptake of increased shares of renewables. This should be suitable for a level of renewables in the electricity system that would allow reaching the EU's binding renewable target for 2030 of minimum of 42.5% (with the aspiration to reach 45%).

The projects are expected to include at least two electricity transmission system operators (TSOs) and five distribution system operators (DSOs). The projects should also involve (not necessary as project partners):

- at least three suppliers of energy from renewable sources, out of which at least two should supply energy from non-dispatchable sources. The supply covered by the project should include both wind and solar energy sources;

- at least two providers of energy services for the grids (e.g. aggregation of energy supply and/or energy demand, energy storage).

The selected projects are expected to contribute to the BRIDGE initiative [38], actively participate in its activities and allocate up to 2% of their budgets to that end.

HORIZON-CL5-2025-D3-18: Next generation distribution substation for increasing the system resilience

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 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:

- Improved monitoring and control of the electricity distribution grids;
- Optimised management of the grids by system operators and improved system resilience;
- Grid operators integrate in their practices real-time decision-making. These could be assisted by artificial intelligence (AI) algorithms, if applicable;
- Creating a 'smart substation ecosystem' that includes distribution system operators, technology/solution providers, integrators, application developers etc.

Scope:

The projects will:

[38] https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/

- Demonstrate the integration of power electronics, intelligent electronic devices (IEDs), and software solutions in the distribution substations or in their proximity;
- Demonstrate real-time monitoring and analysis of grid conditions (including power quality, voltage levels, and system performance) that allow operators to quickly identify and address any potential issues or disturbances, and help to prevent outages and minimise the impact of service disruptions;
- Consolidate data streams from otherwise dispersed sources to create unified visualisations and consolidated analytics that offer insights into the performance of distributions substations;
- Develop the concept of a flexible and programmable electricity distribution grid in which the substation is a centre of intelligence that facilitates optimal power routing while ensuring the resilience of the electricity grid;
- The demonstration, test and validation of the activities should be done in at least two pilots in different EU Member States/Associated Countries.

The projects should propose a set of best practices and recommendations on the effective the overarching principles and operational measures for building smart distribution substations and integrating them into a more intelligent and responsive distribution grid.

The projects are expected to include at least five distribution system operators (DSOs) operating across different geographies and climate conditions. The projects should also involve at least two suppliers of technologies for smart power substations.

The selected projects are expected to contribute to the BRIDGE initiative, actively participate in its activities and allocate up to 2% of their budgets to that end.

HORIZON-CL5-2025-D3-19: Innovation solutions for a digital spine in the EU energy system

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	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:

- Accelerated digital and green transformation of the energy system.
- Increased system reliability, resilience, security, and energy efficiency.
- Enhanced knowledge for modernizing and operating energy networks and integrating digital services, renewables, electrification, and digitalization.

Scope:

The digital spine initiative focuses on digital solutions that enhance the electrification, digitalization, and decarbonization of the EU energy system. The initiative aims to modernize and optimize the information layer of European electricity grids through innovative solutions, including:

- Development of an automated, AI-powered, software-defined, self-healing digital spine for smart energy systems.
- Integration of this digital spine with various data sources and sectors, like mobility, to promote decentralization, energy-efficiency, and cost-efficiency.
- Dynamic, flexible, and reconfigurable management of the digital spine to ensure seamless operations across decentralized settings and compatibility with legacy systems.
- Demonstration of AI-powered energy services across at least three member states to enhance demand flexibility and innovative capabilities for decarbonization and energy conservation.

HORIZON-CL5-2025-D3-20: Innovative tools and services to manage and empower energy communities

Specific conditions	
Expected EU contribution per	

project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	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:

- Integration of home and building assets in an efficient way based on common IoT communication standards for smart homes and using SGAM architecture and data models (CIM) for load, generation and storage devices;
- Facilitate local electricity trading and DSO-oriented grid services using micro market and peer-to-peer transactions and improve the market participation for consumers;
- Enhance the integration of energy communities in the European electricity grid and increase the renewable energy share and use of flexibility by providing a transparent and efficient market-based cost sharing mechanisms;
- Increase the complex security of data exchange, for prosumer and customer resources, and independent (commercial) asset operators.
- Increase synergies using cross-sectoral approach (e.g. electricity, gas, mobility, heating) at the level of customer/prosumer and/or energy communities.

Scope:

The project should:

- Develop innovative and open-source tools for managing shared energy community assets (e.g., energy storage facilities) and optimising energy community management (e.g., implementation/building of energy community, selection and switching of aggregators, preparation and trading of smart contracts), peer-to-peer and energy sharing).

- Develop open-source tools for forecasting, prediction and advanced data analysis using AI tools and in-depth data analysis for customers and prosumers for autonomous optimisation of consumption, production, storage, smart devices (appliances), and EV both at household and energy community levels.

- Extend DSO SCADA and substation systems for autonomous control of grid assets and seamlessly integrate these systems with home and building energy management systems for direct and fast control and data acquisition to implement local (distribution) grid services (constrain alleviation, grid reconfiguration, restoration of supply, maintenance, and enhancement of energy quality), real-time assessment and monetisation of the use of grid resources.

- Integrate the 3 elements above as a basis to establish a platform for cooperation between individual customers or prosumers, entire energy communities, wide area aggregators, DSOs, and TSOs to provide, acquire, and settle power system-oriented services (system-wide balancing, support of frequency regulation). The cooperation platform should be based on a plug-and-play integration of the energy community eco-system components (hardware and software), using and extending relevant communication standards and data models. The integration mechanism should be embedded within the core systems used by customers/prosumers, DSO (and TSO), aggregators and market operators, fully aligned with SGAM.

- Develop tailored security solutions for private and public communication networks used by IoT apps and devices (smart appliances) across all energy carriers.

Preferably semantically interoperable interactions, as enabled by the ETSI SAREF ontologies, are used. Furthermore, the project should follow the IEC TR 63097 Smart Grid Roadmap, and where relevant, the developed solutions should be open for off-shelf integration using common communication and data standards.

The project should benefit from the direct participation of energy communities, smart appliances manufacturers, home energy devices manufacturers, home and building energy management system developers, Distribution System Operators (DSOs), and aggregators.

However, in order to comply with Article 33, 36 and 54 of Directive (EU) 2019/944, TSOs or DSOs participating in this project shall not own, develop, manage or operate energy storage facilities or recharging points for electric vehicles. Moreover, the role of the distribution system operator in facilitating peer to peer trading should be without prejudice to the rules in Article 35 Directive (EU) 2019/944.

The developed solutions have to be tested at, at least, five energy communities from at least three European countries. Technical, and social characteristics should be used in the project to validate the developed solutions' credibility. The demonstration sites should cover complex and technologically advanced energy communities, each located within the range of neighbouring secondary substations supplying a variety of customers/prosumers with close-to-autarky local electricity generation, a full range of energy vectors, a significant share of

storage facilities, and flexible topology already available or to be achieved as an integral part of the project. The secondary substation should be already equipped with advanced monitoring and control systems.

The selected projects are expected to contribute to the BRIDGE initiative, actively participate in its activities and allocate up to 2% of their budgets. 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-CL5-2025-D3-21: Cross-regional network and market model for optimization of long duration storage for planning of transmission and distribution networks

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research Innovation Action
Eligibility conditions	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).
Technology Readiness Level	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 integration of long term (>12h) storage within the context of system wide optimization of grid enhancement strategies in synergy with power plant infrastructure.
- Providing a sophisticated integrated cross-regional network and market model that is capable of comparing marginal abatement costs of different technologies and their combinations.
- Increased knowledge on:

- cost-benefit of low-cost long duration storage integrated in relevant grid locations to optimize cost and operation;
- innovative and sustainable long-term energy storage solutions coupling electricity with other energy carriers to optimise integration of renewables;
- cost-benefits of cross-regional approach to long-term storage and cross-sector integration;
- how to effectively increase grid hosting capacity for renewables and support cost effective decarbonisation;
- how spatially- and temporally- detailed modelling should be to accurately value long-term energy storage;
- sensitivity analysis on which simplifications affect the assessment of long-term energy storage in long-term planning.

Scope:

The project shall be based on a complete understanding of existing systems in at least 2 adjacent regions (NUTS 2 or 3) – best represented in the form of a digital twin (or similar). Consortia shall include the respective system operators and other relevant stakeholders.

This topic aims at demonstrating the value of innovative integration of low-cost, sustainable and highly circular long-term storage in the energy system that can provide cost-effective long-term energy storage under different future decarbonization pathways, assessing the impact on operation and planning of energy infrastructure costs.

The developed solutions are expected to demonstrate high performance in relation with the expected investment and operational costs and business cases in the future energy markets.

The project is expected to identify technical and regulatory barriers, and propose possible recommendations and policy actions, to promote the solutions demonstrated and support their replication.

HORIZON-CL5-2025-D3-22: Underground Thermal Energy Storage in dense urban areas

Specific conditions	
Expected EU contribution per project	
Indicative budget	

Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	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:

- Advance the European innovative knowledge basis and increase technology competitiveness in the area thermal storage;
- Improve the security of the future European renewable-based energy system
- Contribute to the decarbonisation of cities and densely populate urban areas;

Scope:

In scope are novel technologies, interfaces, design methods and organizational concepts that result in the most effective and sustainable use of subsurface space by indirect, direct and storage geothermal systems such as UTES, ATES and BTES systems in dense urban areas.

Proposals should consider the integration in the existing energy grids and interaction with other urban uses of the subsurface (e.g. subways, underground utilities, buildings), including structural foundation elements of buildings, tunnels, slabs, energy sheet pile walls, etc., with potential geothermal heating, cooling, and sinks or storage opportunities.

Proposals should address the uncertainties in the seasonal energy demand to increase the predictability of the required subsurface space, the interactions among systems for the sake of optimal use of subsurface and thermal efficiency.

Projects are expected to deploy one or more demonstrators and can address, for example, one or more of the following exemplary areas:

- Optimal utilization of geothermal resources and thermal energy storage in urban settings;
- Subsurface underground models for a sustainable geothermal use in cities
- Studying the impact of subsurface urban heat islands (SUHI) on the potential of shallow geothermal energy use in cities

- Best practices strategies for subsurface land-use plans in European cities; Well/borehole placement strategies
- Mutual interactions between systems, effect on efficiency of storage, and energy performance

Consideration should be given to de-risking solutions, and dedicated support schemes that guide innovative energy storage technologies through to the commercialisation stage. The consortium should cover all relevant stakeholder groups, assess the current regulatory context and provide recommendations linked to the proposed solutions for shaping the future needs (e.g. regulatory, standardisation, permitting).

HORIZON-CL5-2025-D3-23: Critical elements for energy security of grid and storage technologies

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Award criteria	The criteria are described in General Annex D. The following exceptions apply: No second project will be funded in each of the following energy security related value chain specificity areas, until not all other areas with successful proposals are funded: • Advanced tools to address cybersecurity risks to energy system transmission and distribution and renewables-to storage and storage to energy network interface technologies; • Increasing circular economy processes, recycling, re-use or substitution of sustainably supplied critical materials and

	electronics for energy network and storage technologies; • Sustainability and public perception of energy network and storage technologies as a limiting factor for their required capacity build-up and efficient performance in a secure energy system (e.g. hydropower, CAES storage).
Technology Readiness Level	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:

- Development of advanced solutions strengthening energy security of energy network and storage technologies for renewable energy
- Contribute to strengthening the European technology knowledge Base on Energy system security
- Develop solutions addressing key aspects improving the technological and cross-cutting value chain aspects for energy security of grid and storage technologies
- Improve the security of the future European renewables- based energy system as an important factor in its cost-effectiveness and therefore directly impacting European competitiveness;
- Create European technological leadership in the energy security field and create a knowledge base for European industrial competitiveness.

Scope: Novel solutions, which address specifically critical aspects affecting the energy security of energy network and storage technologies. As energy security of the energy grid and safe storage of variable renewables is directly related to a cost-effective and sustainable European energy system and therefore essential to European competitiveness, not only energy security aspects of the grid and storage technologies as such, but also those related to their respective value chains need to be addressed. Proposals should focus on development of solutions for grid and/or storage technologies, which can highly improve their overall energy security performance in the European context in the long-run.

Project should address precisely one of the following areas:

- Advanced tools to address cybersecurity risks to energy system transmission and distribution and renewables-to storage and storage to energy network interface technologies;
- Increasing circular economy processes, recycling, re-use or substitution of sustainably supplied critical materials and electronics for energy network and storage technologies;

- Sustainability and public perception of energy network and storage technologies as a limiting factor for their required capacity build-up and efficient performance in a secure energy system (e.g. hydropower, CAES storage);

Furthermore, essential skills and efficient skills management within the overall energy network and storage system shall be addressed.

Carbon Capture, Utilization and Storage (CCUS)

HORIZON-CL5-2025-D3-24: New CO_2 capture technologies

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 5 by the end of the project.

Expected outcomes:

New technologies should lead to reduced overall cost of capture through high capture rates and low energy and water use, as well as lowest possible negative environmental impact. In view of the growing need for CCS in so-called hard-to-abate industries, results should provide good matches between specific industrial application and capture technology while guaranteeing the quality and continuity of the industrial process.

Scope:

Development of new or emerging capture technologies with high potential for cost reduction. Projects can address capture of CO_2 either from points sources or directly from air (direct air capture, DAC). Depending on the capture routes chosen, important issues to address include enhanced absorption/adsorption, improved kinetics and reduced energy use for CO_2 capture and desorption, flexibility of operation, modularisation and scale-up, space occupation, degradation and life span of capture technologies, ability for retrofit, potential for heat integration, and solvent-induced corrosion. In particular for DAC, important issues to address are novel sorbent or solvent materials that have higher CO_2 capture capacities and longer-term stability in the presence of heat and air. For new solvents, new materials should aim at low volatility (low solvent loss and minimized emissions). Examples of promising emerging technologies include ionic liquids and deep eutectic solvents. Environmentally benign technologies have to be pursued and their environmental impact addressed in the project also in view of future scaling up.

HORIZON-CL5-2025-D3-25: Effects of CO_2-stream impurities on CO_2 transport and storage

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Actions

Expected outcomes:

Transport and storage of CO_2 from industrial clusters represents specific challenges as it involves CO_2 streams at different flow rates, pressures and states (liquid, gaseous, super critical,…), and with different compositions and impurities. The design and safe operation of a CO_2 transport system therefore requires an accurate understanding of the effects of impure (and possibly corrosive) CO_2 flows along the transport network (in particular pipelines and shipping) and at the point of injection into the storage site.

The Communication on Industrial Carbon Management underlines the need for pre-normative research on the physical and chemical behaviour of impure CO_2 in order to contribute to standardisation work. This was also emphasised in a report prepared by the expert group on CO_2 standards under the CCUS Forum.[39] Results from this topic are expected to contribute to standardisation work through improved understanding of the physical and chemical behaviour of impure CO_2.

Scope:

Projects are expected to

[to be further developed]

HORIZON-CL5-2025-D3-26: Investment atlas of potential CO_2 storage sites

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Coordination and Support Actions

Expected outcomes:

The emergence of a CCS value chain in the EU is currently being hampered by a lack of CO_2 storage sites. In the Net Zero Industry Act, the Commission has proposed that at least 50 million tonnes of CO_2 per year can be stored geologically by 2030, in storage sites located in the territory of the European Union, its exclusive economic zones or on its continental shelf within the meaning of the United Nations Convention on the Law of the Sea (UNCLOS) and which are not combined with enhanced hydrocarbon recovery. Results from this topic are expected to contribute to enhancing the availability of CO_2 storage sites and providing transparency about potential CO_2 storage capacity, which can support market operators to plan their investments.

Scope:

The project should produce a digital atlas of 'investable' underground storage space for CO_2. The European CO_2 Storage Atlas[40] hosted by the JRC presents a good basis, but also shows that data gaps need to be closed. Use can also be made of the Commission's Energy and

[39] https://circabc.europa.eu/ui/group/75b4ad48-262d-455d-997a-7d5b1f4cf69c/library/13c2a475-c705-432d-8ca3-17ce799ba502/details

[40] European CO2 storage database - European Commission (europa.eu)

Industry Geography Lab[41]. Each potential storage site must be labelled according to its 'storage readiness level' and matched with public data to speed up the work to identify and assess the storage capacities. Environmental aspects must be taken into account.

The proposal must explicitly demonstrate a proven track record in CCS as well as the capacity to have access to the necessary data during the implementation of the grant. Cooperation with relevant national and/or regional actors in the management of the subsurface, such as geological surveys or competent authorities, will be key.

Cross-cutting issues

HORIZON-CL5-2025-D3-27: Clean Energy Transition Co-funded Partnership

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Programme Co-fund Action
Eligibility conditions	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 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.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The evaluation committee can be composed partially by representatives

[41] Energy and Industry Geography Lab - European Commission (europa.eu)

	of EU institutions. 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.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: This action is intended to be implemented in the form of an amendment to the grant agreement concluded pursuant to topic HORIZON-CL5-2021-D3-01-04. For the additional activities covered by this action: • 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. 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.
Total indicative budget	The total indicative budget for the co-funded European Partnership is EUR 210 million for the period 2021-2027.

Expected Outcome: This topic is for the continuation of the Clean Energy Transition Co-fund partnership (CET Partnership), i.e. EU contribution for the period 2025-2027..

The third 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 development of new 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 a climate neutral economy 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 and energy efficient 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. . This 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 REPowerEU[42] 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 its ambition considering the revised SET Plan and continue the implementation of its SRIA by setting up joint calls in 2025, 2026 and 2027. The partnership can consider to set-up also joint calls without co-funding from the Union.

Taking into account that the present action is a continuation of the topic HORIZON-CL5-2021-D3-01-04 necessitating 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 would

[42] REPowerEU: affordable, secure and sustainable energy for Europe | European Commission (europa.eu)

take into account the existing context and the scope of the initial evaluation as relevant, and related obligations enshrined in the grant agreement.

Destination – Efficient, sustainable and inclusive energy use

This Destination targets the energy demand side, notably a more efficient use of energy in buildings and industry. It contributes to the activities of the Strategic Energy Technology Plan (SET Plan) and its implementation working groups.

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *'Using energy in buildings and industry in an efficient, affordable and sustainable way'*.

The main impacts to be generated by topics under this Destination are:

Highly energy-efficient and climate neutral European building stock

1. The life-cycle energy performance and resource efficiency of the European building stock is improved at an accelerated pace and contributes to the EU's energy security.
2. The renovation and construction are cost-efficient, affordable and less disruptive, have reduced climate and environmental impact through circularity, and use of low-carbon materials.
3. The buildings in Europe are increasingly interacting with the users, energy system and their environment contributing to an integrated, resilient, secure and flexible operation.
4. The buildings and built environment in Europe mitigate climate change and are more resilient.
5. The built environment is inclusive and delivers a better quality of life for all users.

Industry

The energy efficiency of EU energy intensive industries is improved, their consumption of fossil fuel and their GHG and other pollutants emissions are drastically reduced, while preserving / enhancing their global competitiveness.

Highly energy-efficient and climate neutral European building stock

HORIZON-CL5-2025-D4-01: On-site innovative robotics and automated solutions and techniques for more sustainable and less disruptive building construction and renovation

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	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]

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

[43] 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

- Measurable reduction in overall construction costs and time spent on site for construction and renovation compared to conventional practices.
- Measurable increase in resource efficiency and accuracy of on-site construction and renovation works compared to conventional practices.
- Measurable reduction in noise, particulate matter and other pollution caused by on-site construction and renovation works, compared to conventional practices.

Scope:

Buildings need to be sustainable and resource efficient, and the rate of deep renovation of existing buildings needs to be increased. This can be accelerated by modernising the construction sector and embracing the latest developments in automated techniques. There is need for further research on innovative robotics and other automated on-site solutions and techniques that make construction and renovation works more sustainable, less disruptive, faster, more accurate, more cost effective and more resource efficient.

Proposals are expected to address all of the following:

- Test and validate the use of on-site innovative robotic and automated solutions and techniques both for construction of buildings and for renovation of which at least one must investigate 3D printing.
- Apply a research methodology which allows for a robust comparison of the proposed innovative solutions and techniques with current best practice.
- Investigate aspects of workers' safety and on-site human-robot collaboration related to the future application of the proposed solutions and techniques.
- Test and validate at least three prototype solutions and techniques to investigate their applicability for a variety of building typologies representative of the European building stock. The prototypes should be validated in a lab or another relevant environment. Testing and validation must address solutions for both new construction and renovation. The prototypes should be applicable either to new construction, or to renovation, or to both, but both new construction and renovation need to be addressed in a proposal.

HORIZON-CL5-2025-D4-02-SRP: Smarter buildings as part of the energy system for increased efficiency and flexibility

Specific conditions	
Expected EU contribution per project	

Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

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

- Measurable reduction in buildings' energy demand together with a reduced gap between their as-designed and as-built energy performance.
- Measurable increase in the number of building typologies with SMART grid connected renewable energy sources (RES) and energy storage together with increased flexibility in grid/network management and operations.
- Measurable enhancement of the smart readiness of buildings as rated by the Smart Readiness Indicator and/or other relevant building rating systems.
- Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake and building trust in results and outcomes.

Scope: Buildings remain among the least digitised sectors. Smart buildings can contribute to reducing energy demand, curbing operational CO_2 emissions, integrating RES and enhancing grid flexibility through optimised energy usage. At the same time, it is essential that smart buildings contribute to flexible and adaptive usage patterns and are user-friendly to encourage widespread adoption of these technologies by grid operators, construction professionals, building facility managers and users.

Proposals are expected to address all of the following:

- Develop solutions that enhance the smartness of buildings and upgrading existing Building Management Systems (BMS) and/or other technical equipment.
- Ensure that the proposed solutions are user-friendly and provide the expected indoor environment quality and user satisfaction.
- Demonstrate the proposed solutions in at least three pilots, covering different climatic zones, building types (residential, tertiary etc.), and technical building systems.
- Develop a methodology to measure the achieved energy demand reduction, increased flexibility in the grid, and enhanced interoperability, compared to current best practices.
- Investigate the cost-effectiveness and replicability of the proposed solutions.

This topic is a Societal-Readiness pilot:

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.
- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related activities.

HORIZON-CL5-2025-D4-03: Innovative pathways for low carbon and climate resilient building stock and built environment (Built4People Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 4-5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	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). [44].

Expected Outcome:

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

- Measurable increase in the number of replicable and scalable planning approaches and building solutions to tackle energy performance, sustainability, climate resilience, safety and durability of buildings and the built environment;
- Measurable increase in awareness of relevant construction and value chain actors on replicable and scalable holistic planning approaches and building solutions;
- Measurable improvement in buildings' and built environment's energy performance and climate resilience.

Scope: In a society subject to rapid and disruptive changes, buildings and the built environment should exhibit flexibility to adapt to modified social, economic and environmental conditions without adding environmental or sustainability burdens on society and users. There is a need to develop building solutions and urban planning processes, for the relevant construction and value chain actors, municipal and regional authorities and policy makers, as the basis for ensuring successful pathways to climate neutrality and climate-resilience of the EU building stock.

Proposals are expected to address all the following:

[44] 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

- Develop and validate innovative technological solutions that support the decarbonization and climate resilience of buildings and the built environment, addressing energy performance, sustainability, climate resilience, safety and durability of the building stock and whole life carbon reduction. These solutions must cover at least nature-based solutions and local renewable energy generation and consumption.

- Develop and validate urban planning processes for applying these solutions and integrate these solutions in new or existing planning tools.

- Validate the planning processes and technological solutions in a relevant environment in at least three different countries, with diverse climatic conditions and building stock characteristics. At least two of these solutions should be relevant for renovation.

- Ensure that the integration of innovative tools, products and techniques enables construction and renovation processes to facilitate adaptability to changing user needs.

- Develop a methodology for assessing the effectiveness of the proposed solutions, which incorporates whole life carbon reduction and life-cycle global warming potential.

- Ensure the active involvement of all relevant public and private stakeholders of the whole renovation and construction value chain which must include among others: municipalities, and the building and construction sector professions.

- Contribute to the objectives of the Built4People partnership and to the Built4People network of innovation clusters[45].

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-CL5-2025-D4-04: Innovative approaches for autonomous, smart, climate neutral and inclusive Positive Energy Districts

Specific conditions

[45] https://built4people.eu/nebula_project/

Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

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

- Increased number of approaches and solutions enabling a net positive yearly energy balance at district level and the export of excess renewable energy to the grid outside its geographical boundaries, with enhanced replicability on a larger scale in other PEDs in different contexts.
- Demonstrated consideration of and adaptation to diverse societal interests and concerns in the demonstration PEDs, compared to the current situation.
- Improved user-friendliness and user-awareness of guidelines, tools, and training materials for overcoming barriers towards the realisation of positive energy districts (PEDs).

Scope: Recent projects have demonstrated the feasibility of positive energy districts, but there is a need to further develop and demonstrate innovative approaches and solutions for overcoming technical, business, and organisational constraints in several domains. Such domains include, for example, the integration of renewable energy sources and energy storage in buildings, grid connections, accommodation of distributed energy generation and storage at district level, permitting, data privacy and security and the application of new technologies such as artificial intelligence. Presently, these constraints, which inhibit the demonstration of

complete and qualified PEDs, require the cooperation of stakeholders from the public and private sector, such as municipal and regional authorities and the whole construction sector value chain, in complex implementation processes.

Proposals are expected to address all of the following:

- Demonstrate innovative approaches and solutions for overcoming constraints which prevent the successful implementation of PEDs.
- Develop supportive implementation frameworks for the design and realisation of PEDs.
- Demonstrate the proposed approaches, solutions, and supportive implementation frameworks in at least three districts in diverse geographical areas that implement energy efficiency measures alongside renewable energy installations, storage solutions, digital and smart technologies, and local energy communities.
- Develop and/or update existing guidelines, tools, and training materials for key professionals that will enable other cities to successfully replicate these innovative approaches and solutions as well as supportive implementation frameworks in their district/cities.
- Ensure the active involvement of all relevant public and private stakeholders, including citizens, through stakeholder participation processes and community engagement activities that foster community support and inclusiveness.

HORIZON-CL5-2025-D4-05: Optimal combination of circular principles, low embodied carbon construction products, and technical building systems for climate neutral buildings (Built4People Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research & Innovation actions (RIA)
Eligibility conditions	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).
Technology Readiness Level	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:

- Measurable reduction in whole life-cycle greenhouse gas emissions and uptake of carbon removals in buildings and renovations.
- Increased integration of circular approaches for building and renovation works, with the aim of minimising lifecycle impacts.
- More accurate benchmarking and calculation of typical buildings' whole life cycle greenhouse gas emissions and carbon removals, based on Level(s) and consistent with the life-cycle global warming potential under the Energy Performance of Buildings Directive.

Scope: New buildings and renovation works result in greenhouse gas emissions over their whole life cycle (operational and embodied emissions). Buildings can also contribute to long-term carbon removals by storing carbon in construction products. As well as reducing their climate-related impacts, construction works must meet a variety of inter-related requirements such as structural and fire safety, acoustics, and a healthy and comfortable indoor environment. Although much research has focused on developing materials and products with a lower carbon footprint, the whole life cycle impact and performance of buildings depends on a complex interaction between individual products, components and technical building systems, spatial distribution, and other design choices. There is therefore a need to develop buildings and renovation works with minimal life cycle impacts, in particular global warming potential, based on circular design, also accommodating future building use-change through design for flexibility, and using innovative combinations of products and systems that result in optimal building-level performance.

Proposals are expected to address all the following:

- Develop technologies and solutions that facilitate optimal and innovative combinations of construction products and systems with minimal life cycle impacts at the level of the building. The innovative combinations of products and systems must also account for relevant aspects of performance such as thermal, acoustic and hygrometric performance, durability, potential for deconstruction and preparation for reuse at end of life, and potential for automated or industrialised installation. The technologies should be related to the design and construction phases of work.

- Validate the technologies and solutions in a relevant environment in at least three different countries, with diverse climatic conditions and building stock characteristics.
- Research the whole life carbon impact of typical building typologies in the chosen countries, using the developed technologies and solutions, and contribute to whole life carbon benchmarking efforts.
- Investigate the cost effectiveness of the developed technologies and solutions including relevant business models that integrate circularity principles and monetization of carbon removals, in the chosen countries, and must address both urban and rural contexts.
- Develop processes and related strategies for adaptive reuse of existing structures, such as repurposing buildings as opposed to demolish and rebuild, considering the whole life carbon impact.
- Contribute to the development of European standards, where relevant.
- Contribute to the objectives of the Built4People partnership and to the Built4People network of innovation clusters[46].

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.

Industry

HORIZON-CL5-2025-D4-06: Phase out fossil fuel in energy intensive industries, through the integration of renewable energy sources

Specific conditions	
Expected EU contribution per project	
Indicative budget	

[46] https://built4people.eu/nebula_project/

Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	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:

- At least one energy intensive industrial subsector in the EU improves its energy efficiency, and significantly reduces its consumption of fossil fuel and its emissions of GHG and other pollutants, while preserving / enhancing its global competitiveness.
- With the ultimate goal of completely phasing out the use of fossil fuels in an industrial plant with a significant heating/cooling demand, the energy supply of the process(es) relies on the local integration of a combination of renewable energy sources.

Scope:

Proposals are expected to demonstrate a solution for the efficient and cost-effective local integration of a combination of renewable thermal/electrical/bio energy sources in industrial processes, possibly using renewable combined heat and power (CHP) generation, while optimising process efficiency and reuse of excess heat, with the aim of drastically reducing fossil fuel use.

Process flexibility and energy storage can also be integrated, to match the energy demand of the industrial process with the variable renewable energy supply profile, and to minimize electricity demand from the power grid.

The solution shall be designed to ensure that the industrial process has very low GHG and other pollutant emissions, high reliability and safety, and high physical and cyber security. It shall be physically demonstrated in an industrial environment and cover a significant share of the total energy demand of the industrial plant. The project shall demonstrate through numerical simulations that the physically demonstrated solution can be scaled up to cover almost all of the plant's energy demand.

The project shall facilitate the future deployment of the solution in the EU plants in the same industrial subsector(s). Already before starting the design phase, the needs of the EU factories in the same subsector(s) will be surveyed and analysed in order to design a solution that can

be adapted to meet most of them, to identify common components to be optimised/standardised and to issue/disseminate technical and economic guidelines.

Proposals are expected to present a strong business case and sound exploitation strategy for the proposed solution, as outlined in the introduction to this Destination. As a project output a more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan and financial model) indicating the potential funding sources (e.g. Innovation Fund, InvestEU, ESIF)

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 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 directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *'Achieving sustainable and competitive transport modes'*.

The main impacts to be generated by topics under this Destination are:

Zero-emission road transport

1. Clean solutions for zero tailpipe emission and environmentally friendly mobility for a climate neutral and zero pollution mobility with a higher level of circularity.
2. Affordable, user-friendly, inclusive, safe, and secure concepts and technologies that are easy to deploy, considering needs, behaviours, and socio-economic status of end-users.
3. Increased global competitiveness of the EU transport sector.
4. Increased user responsiveness of zero tailpipe emission vehicles and systems to diverse societal interests and concerns.
5. Use cases and concepts for zero-emission road mobility of people and goods are successfully and innovatively demonstrated.

Aviation

1. New and updated Aviation Research and Technology Infrastructures, where the new research and technologies will be developed and tested.
2. Increased understanding and analysis of mitigation options of aviation's non-CO_2 climate impacts. New technologies for significantly lower local air-pollution and noise.
3. Accelerated uptake of sustainable aviation fuels in aviation, including the coordination with Member States and private initiatives.

Waterborne transport

1. The shipping industry (shipowners, equipment manufacturers, port authorities, terminal operators, and shipbuilders) will have access to high-power low and zero emission fuel solutions by 2030, leading to lower costs, enhanced energy efficiency, risk mitigation, standardised implementation, and improved operational efficiency through data science.

2. Port operators and ship owners will benefit from increased safety and technical standards on ammonia and hydrogen bunkering, including failure scenarios and risk mitigation.

3. The shipping industry will benefit from lower-cost and flexible battery-based solutions as primary sources of energy, higher safety standards and broader electrification solutions.

4. Shipowners, ship operators and port authorities will have access to OPS (Onshore Power Supply) solutions that will enable them to comply with the current and incoming legislative framework.

5. Policy makers and shipowners will benefit from access to accurate information and assessment methods on the direct energy savings resulting from the use of wind-assisted propulsion (WAP) systems under current legislative frameworks like FuelEU Maritime, contributing to the assessment of GHG intensity of energy used on-board. Shipowners, shipbuilders, and European shipyards will have access to commercially viable, cost-efficient, and easy-to-retrofit WAP solutions deployed at commercial scale, particularly for long-distance shipping.

6. Shipyards will have innovative holistic intelligent design tools for various retrofit solutions, enhancing the competitiveness of European shipyards and marine equipment providers.

7. Governments, port authorities, and shipping companies will benefit from access to standardized systems and tools for monitoring air pollutants and fuel consumption of ships, enabling compliance with current and incoming regulations on ship emissions.

8. Policymakers and enforcement bodies will benefit from innovative tools to fulfil the requirements of the Ship Sourced Pollution Directive resulting in an increased environmental protection of sea waters.

Transport related environment and health

The better monitoring of the environmental performance and enforcement of emissions regulation and biodiversity protection in order to reduce the overall environmental impact of transport (e.g.: as regards biodiversity, noise, pollution and waste) on human health and ecosystems.

Zero-emission road transport

HORIZON-CL5-2025-D5-01: Efficient wireless bidirectional charging solutions

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- Bidirectional, interoperable low-power wireless charging solutions for Light Duty Vehicle demonstrated, with significantly reduced losses of power transfer and increased robustness against humidity and dirt.
- Enhanced electro-magnetic compatibility (EMC) within health, safety limits and not causing interference with telecommunication or navigation systems.
- Enhanced social responsiveness to automatic park and charge functionality demonstrated in on-street parking and parking lots.
- Demonstration of the solutions with constant grid integration.
- High efficiency with complete cost assessment at system level.

Scope: Wireless charging can be a solution to conductive to minimise the intrusiveness of the charging infrastructures, a critical aspect in urban environments. The holistic system approach of EV integration into electricity grids entails bi-directional power between EV and the grid to maximise the battery capacity exploitation for grid-and market-oriented services. So far, there is limited research on wireless bidirectionality of charging technologies and the efficiency that can be achieved.

Proposals are expected to address the following aspects:

- Design, develop and demonstrate cost-effective, visually not intrusive, efficient technologies, solutions and user-centric services for bi-directional automatic wireless chargers.

- Assessment of potential cybersecurity risks associated with the bidirectional charging.
- Increase comfort and social responsiveness of parking by auto-positioning of vehicle and/or antenna(s).
- Avoid detrimental effects from obstacles such as garbage or amounts of dirt that might interfere with the power transfer and/or might cause damage.
- Investigate ways to maximise efficiency through plate design and positioning.
- Efficient system integration of bidirectional wireless charging infrastructures and services to support RES deployment, grid balancing, and investments analysis.
- A low environmental impact by reducing critical materials and favouring reusability and recyclability: LCA analysis and highest circularity of raw materials usage should be considered.

HORIZON-CL5-2025-D5-02: Cybersecure and resilient e-mobility ecosystem

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- A (holistic) architecture or platform integrating cyber-resilient hardware and software modules, such as Hardware Secure Modules considering state-of-the-art cryptographic primitives/technologies (i.e. Post-Quantum Cryptography) to enhance the security, resilience, and robustness of e-mobility systems.
- Implemented AI automation frameworks/tools/platform for testing, verification, and certification on industry standards and best practices for security, resilience, and robustness of e-mobility systems.

- Testing and certification methods and use cases (Hackathon …)
- Hardened Electric Vehicle Supply Equipment (EVSE) against natural hazards, vandalism and criminal tampering by cyber-attacks and physical intrusion.

Scope: The system approach of the e-mobility entails the interconnection of several e-mobility actors with the technologies (EVs, EVSEs) and e-mobility users but also the establishment of communication interfaces among e-mobility/energy actors via different ICT systems and back-end systems. On one hand, the charging infrastructures shall be open and accessible to everyone, for all users, all types of EVs, software systems, charging protocols and apps, and, on the other hand, it must be secure from hackers, criminals and other malicious parties. It is critical to ensure that all these interactions are secured and reliable. A cyber-attack on any level of the e-mobility ecosystem may have financial and/or operational implications which might result in wider disruptions, up to nationwide power outage.

Proposals are expected to address the following aspects:

- Develop a secure architecture-by-design and secure design principles encompassing all components and interfaces within the e-mobility ecosystem.
- Consider the HW/SW elements and communication channels spanning from vehicles to charging stations and the electricity grid as a proactive design to mitigate vulnerabilities across the entire chain.
- Implement a shared system of systems testing approach and develop co-designed verification and certification methods.
- Consider a comprehensive penetration testing framework on hardware and software components to uncover potential weaknesses and vulnerabilities.
- Consider a thorough threat analysis and risk assessment to identify potential security vulnerabilities within the ecosystem.
- Extend Public Key Infrastructure (PKI) deployment, while considering emerging cryptography threats (i.e., quantum crypto) and exploring solutions, particularly focusing on pre-emptive measures against Post-Quantum Cryptographic attacks.

HORIZON-CL5-2025-D5-03: Safe Post-crash Management of BEVs

Specific conditions	
Expected EU contribution per project	
Indicative budget	

Type of Action	
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- Best practices in fire handling and fire suppression, rescue procedures and handling of crashed BEVs.
- Improvement of vehicle designs from the perspective of fire-hazard reduction, fire suppression and post-crash handling.
- Advanced BEV condition assessment methods and tools with a focus on the condition of the battery as the most critical sub-system.
- Re-use/re-cycle of batteries from crashed BEVs facilitated by tailored interventions and high confidence in battery health condition, thus supporting potential second-life applications of batteries from crashed BEVs.
- Safety concerns of (potential) BEV users as well as decision makers addressed by science-based communication and comparative statistics.
- Fire risk assessment of parked BEVs in confined spaces and establishment of risk-reduction techniques for the perusal of the operators of these spaces.

Scope: While there are many similarities to ICEV fires, electric vehicle battery fires pose a range of new challenges to emergency responders and everyone handling EVs post-incident, including tow, repair, storage, salvage & wrecking. In addition to protection during the collision, it is the post-crash phase, immediately after the collision, that is crucial for the consequences of a crash. The rescue of victims, the safety of first responders and safe, efficient and timely firefighting measures are key factors here. This can be a challenge in particular in confined spaces.

Proposals are expected to address the following aspects:

- Fire extinguishing techniques and firefighting procedures for BEVs, considering the risks from toxic products of the associated chemical reactions specific for EV, as well as vehicle designs supporting firefighting. With regard to design aspects, particular attention should be paid to the design of the battery pack and its integration into the vehicle.
- Extrication procedures protecting both crash victims and emergency service workers to the best possible extent.

- Vehicle health assessment tools after a crash, with a focus on the assessment of the battery and high-voltage system condition, ensuring that the HV battery is in a safe and stable condition (avoidance of thermal runaway after a collision). Both on-board monitoring systems and off-board systems can be considered. Making use of connectivity to on-board monitoring systems, the accessibility to the health and safety information / data needs to be addressed.

- Methodologies and tools for the safe handover, handling, transport, storage and disposal of crashed BEVs, including removal of the battery.

- Risk analysis and determine the causes of charging-connected BEV fires; evaluate additional hazards compared to non-connected vehicles and identify the most common fire incidents for connected BEVs. Separate fire risk assessment for vehicles connected to AC or DC charging in confined spaces.

- Key project results should be showcased in a real-life demonstration in comparison to the state-of-art. This shall include the demonstration of BEV condition assessment tools, fire extinguishing media as well as firefighting, rescue and handling procedures on a full production vehicle.

HORIZON-CL5-2025-D5-04: Extended lifetime of Battery Electric Vehicles

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- Holistic improved understanding of ageing and degradation and identification of critical functions and sub-system of Light Duty BEV enabling user-centric designs for longer life to minimize the negative impact on the environment and the society.

- Future sustainable, economy-design concept evaluation for extended lifetime with minimum use of resources and re-use, recycle End-of-Life strategies applicable for advanced technology development.

- Advanced prospective/prescriptive maintenance and repair concepts to extend useful lifetime of BEV and minimize the used resources.

- Extended lifetime of BEV to increase material productivity (through reduced TCO) and to minimise the environmental footprint.

Scope: The need for circular economy approaches contributing to the Green Deal objectives as well as important element to secure European resource sovereignty demands for a holistic approach utilizing all of the so-called 9R principles. Besides circular material flows as addressed in the upcoming regulation on circularity requirements for vehicles, including the ELV directive, the extension of the lifetime of vehicles and its sub-systems is one important measure defined in the 9R principles. However, for BEV with its high value sub-systems like the electrified drivetrain (e-motor, battery, power electronics), that are critical to the economic aspect of the vehicle life.

Proposals are expected to address the following aspects:

- Analyse holistically the ageing and degradation of BEV functions and critical sub-systems, that determine the Vehicle Lifetime under the aspect of functionality, safety and economic considerations.

- Develop tools and methods to assess and measure ageing and degradation of critical sub-systems (e. g. modelling, non-invasive evaluation, multi-physical testing, etc.)

- Develop maintenance, refurbish and repair concepts for BEV.

- Develop extended lifetime concepts for BEV, by expanding the elements on the critical, life-time defined path (e.g. definition of prospective maintenance strategies, implementing ageing / degradation models into the design, advanced control strategies to minimise operational loads contributing to ageing and degradation phenomena including sensor technologies to obtain real-life operational data).

- Validation and demonstration of concepts and designs, to assess the life-time expansion with regard to the 9R approaches.

- For critical components follow the “passport” approach, to achieve maximum traceability.

- Data management for operational loads, maintenance and repair measures.

HORIZON-CL5-2025-D5-05: Optimised user-centric energy efficiency design

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- Holistic approach to suitable and affordable energy management solutions.
- Innovative heating, cooling and demisting components and affordable user-oriented solutions for efficient cabin conditioning with regards to thermal comfort, humidity and CO2.
- Optimal energy management including integration of future smart cities standards (e.g. speed control, environmental forecasting, swarm information, smart energy management), considering grid impact especially under extreme weather conditions and during potential peak load periods.
- Predictive energy management – balancing load with supply (e. g. better use of physical effects optimizing thermal mass effects).

Scope: The improvement of efficiency is strongly dependent on user acceptance, preferences, and usage scenarios for the vehicles. Improvements can improve range or reduce battery size, whereas improvements in charging mode will have an impact on the overall usage of renewable energy. Measures to improve efficiency need to focus on regular usage models and maximize the potential of intelligent solutions for occasional or rare usage outside of regular daily usage, in order to ensure the overall optimised and efficient usage of resources.

Proposals are expected to address the following aspects:

- Better understand user expectations, sensitivity, tolerances and responsiveness to societal needs and concerns.
- Establish holistic approach to optimizing energy efficiency and relevant thermal functions (system-oriented solutions based on usage scenarios and inclusion of external data for optimal use)

- Automotive standards should be met, keeping in mind that extreme weather conditions should be tackled based on intelligent solutions and an overall system approach (including infrastructure) to minimize and simplify energy and thermal systems.
- Develop innovative vehicle energy management solutions for seldom extreme weather conditions with also using AI-based functions, and intelligent management of auxiliaries.
- Design of innovative cooling modules and heat exchangers – also for optimal operation in simplified vehicle system solutions.

HORIZON-CL5-2025-D5-06: Balance strategies, tools and concepts for Heavy Commercial Vehicles operations

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

- Accelerated innovative HD-BEV solutions that optimize battery and charging infrastructure for long-haul cross-border goods logistics operations in Europe.
- Cross-border services for efficient operational planning of vehicle charging in route optimisation, for vehicles and logistics fleets.
- Fast and broad implementation of HD-BEV solutions enabled by enhanced understanding of user needs, also long-term usage models, including modular vehicle solutions as enablers for right-sizing.

Scope: Proposals are expected to address the following aspects:

- Develop and test concepts for HD-BEV long-haul transport missions along the TEN-T corridors through different logistics models, modular vehicles set up and linking the concept of fast charging with logistics needs.

- Define new logistic operational models allowing a scalable deployment of HD-BEV in long haul transport missions optimising the different variabilities of a shipment (range, charging time, drivers breaking times etc.) minimising impact on operations compared to conventional solutions.
- Use cases shall demonstrate the applicability of new vehicles, logistic models and charging systems in long-haul operations along the TEN-T corridors for extended periods of time.
- Develop models allowing strategies for firm upscaling, taking account the performance of full vehicle concepts, considering the effects of on-board batteries on the ageing and energy efficiency of components such as brakes, tyres, ADAS and energy harvesting in braking.
- Models should be developed and validated, as well as exploring the feedback from haulers (and other users) on how deployment works for them (success stories, barriers).

Aviation

HORIZON-CL5-2025-D5-07: Next Generation Testing Capabilities in Strategic EU Wind-Tunnels

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility conditions	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).
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected outcomes: Project results should focus to new and adapted testing capabilities in EU strategic wind-tunnels for aerodynamic, handling qualities and acoustic tests, towards a competitive and climate-neutral aviation ecosystem. Project results are expected to contribute to at least two of the following expected outcomes:

- new concepts of fuselage-propulsion integration, in-line with the updated SRIA;
- high aspect ratio and/or highly flexible unfuelled wing;
- distributed hybrid/electric propulsions with or without boundary layer ingestion;
- exterior/interior acoustics from unducted fans – either independently or coupled.

Scope:

The Competitiveness Council conclusions of 2 December 2022, as well as the New European Innovation Agenda, have recognised the need to further strengthen the European research and technology linked to strategic facilities, as they can greatly contribute to the competitiveness of the European economy.

In parallel to ongoing research policy initiatives which aim to define the future EU landscape and funding programmes to support technology infrastructures, the advancement of science and technologies is necessary for the development of new and adapted testing capabilities. EU wind-tunnels is a prime example of such strategic capabilities towards climate-neutral aviation. The Horizon 2020 RINGO project has provided an analysis of needs, gaps and overlaps of European Aviation R&I Infrastructures in order to reach Flightpath 2050 goals, while a recent internal effort has updated, refined and prioritised those findings.

The scope of this topic is focused on new critical physical phenomena that need further research, in order to update relevant strategic EU testing capabilities. While new instrumentation and development of digital tools is within the scope of this topic, extensive RTI investments are outside the scope.

The complexity of multi-disciplinary design and optimisation of future aircrafts requires extensive computational efforts and validated wind-tunnel experimental data. The scope of this topic is confined to the strategic priorities and proposed aircraft concept of the updated SRIA, with emphasis on the integration of open fan and UHBR engines on the airframe, the adoption of high aspect ratio, highly flexible unfuelled wing (LH2 aircraft) or boundary layer ingestion and distributed hybrid/electric propulsions.

The projects should be guided by European aircraft integrator(s)/high-tier, or exploit synergies with other EU/National projects in order to prioritize experimentally and numerically demanding cases. The projects should also define and agree upon open interfaces, common architectures and common data formats between simulation, (and future ground and flight experiments – which are outside the scope of this topic).

HORIZON-CL5-2025-D5-08: Next Generation Aircraft Autonomy Technologies for Cockpit / pilot assistance applications

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility Conditions	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).
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected outcomes: Project results should contribute to the European aircraft cockpit technology roadmap 2025-2050+ on crew assistance/automation/autonomy, with focus to next generation aircraft autonomy technologies for cockpit / pilot assistance applications. Project results are expected to contribute to all of the following expected outcomes:

- Increasing safety and affordability in an era where new capabilities, new aircraft platforms and new operating environments require new systems or systems with different functionalities;
- Increasing integration levels by reduced production times and first-time-right delivery;
- Reduction of size, weight and power consumption (SWAP) of systems and equipment and reduced total lifecycle costs.

Scope:

Next generation aircrafts will be even more digital and automated, will have an even more modern digital interface for the crew, will be more interactive and will be even more reliant on automation for safe and efficient operation. However, automation is also prone to significant errors when misunderstood, especially if this is combined to new aircraft platforms.

The projects should develop new technology bricks in-line with the aircraft concepts proposed in the updated SRIA and build upon the results of the H2020-CS2 Large Aircraft Disruptive Cockpit Demonstrator.

The technology bricks should be aligned with the new requirements and cockpit philosophy of European aircraft integrators for the next generations of aircrafts, while they should be cyber-resilient and controlled by a single pilot and without the assistance of an on-board human co-pilot.

The focus is on development of new technologies, rather than on integration and demonstration.

Waterborne transport

HORIZON-CL5-2025-D5-09: Innovative solutions for energy conversion and safety of low and zero-carbon fuels in waterborne transport (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	IA
Technology Readiness Level	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected outcomes: Project output and results are expected to contribute to the following outcomes:

- The waterborne industry will have near-to-market solutions for the safe integration and use of low and zero-carbon fuel power conversion systems as the main power source for vessels above 5,000 GT.
- Equipment manufacturers and ship owners will have access to a knowledge repository to support standardization for using zero and low carbon fuels and ensuring technical compatibility between the fuel and energy conversion system.
- Public authorities, port terminals and ship operators will have access to a knowledge repository to identify hazardous scenarios for the zero and low carbon fuel/s used in

the demonstration and impact in ports, including risk control options, as well as development of protocols for safe response operations in case of an accidental release of zero or low-carbon fuels.

- Equipment manufacturers and shipyards will gain an increased competitive advantage due to the development of ship concept designs in software demonstrating optimized integration of energy technologies with overall energy efficiencies at least 60% in shaft propulsion.

- Seafarers and port workers will gain competences and training in bunkering operations and port authorities' authorizations.

- The EU waterborne industry will see its competitiveness increased through market uptake of low and zero carbon fuel solutions.

Scope**:** The IMO's GHG revised strategy of 2023 and the FuelEU Maritime Regulation have set ambitious goals to reduce the use of fossil fuels in maritime transport. To that aim, maritime operators are working to replace the currently used engines with alternative power conversion systems that will allow the use of low and zero-carbon fuels for propulsion. Among all ship-types, the decarbonization of long-distance shipping will rely the most on successful innovative solutions with high power outputs enabling the use low and zero-carbon fuels as the main propulsion energy source. Research challenges still remain in the integration on-board of powerful power conversion systems. This topic aims to integrate various available fuel cells and ICEs solutions used in waterborne transport running on low and zero-carbon fuels and scaling-up their technological maturity on-board. For fuel cells, research is still needed on integrating different types of high-power fuel cells and the application of ammonia and methanol into current ship systems as well as optimizing its operation together with all systems in a ship. While the current power output using fuel cells is lower than using ICEs, the former is more efficient than the latter.

Therefore, taking this into account, proposals must address all the following aspects:

- One full scale demonstrator of a vessel above 5 000 GT with at least 50% of its total energy supply provided by low and zero-carbon fuels, showing the potential of integrated systems for 100% energy load provision under normal operations.
- The 2 awarded proposals must be complementary, not demonstrating the same power conversion system and fuel solutions, addressing at least one of the following challenges:
    - Projects demonstrating fuel cell solutions are expected to deliver results that will reach a power output of at least 5 MW
    - ICEs solutions are expected to demonstrate a power output of at least 10 MW when using ammonia.
- An innovative storage and handling solution on-board of ships, together with the development of new fuel injection systems and mixing of sustainable alternative fuels with sustainable or low carbon pilot fuels. ICEs solutions should demonstrate a

reduction in the use of pilot fuels compared to solutions on the market at the time of the publication of this call, aiming to avoid the use of pilot fuels at all.

- Solutions to prevent and mitigate slippage and fugitive emission factors related to the use of these fuels.
- Demonstrate optimized integration of energy technologies with overall energy efficiencies for shaft propulsion of at least 60%, able to operate on low and zero-carbon fuels and close to zero direct pollutant and harmful ship emissions.
- Identification of specific gaps in standardization linked to the integration of the technologies researched and development of a roadmap to gather and disseminate the relevant data in support of standardization, including early communication and discussion with relevant bodies.
- Development of parameters ensuring technical compatibility between the fuel and energy conversion system.
- Provide quantitative and qualitative validated risk and safety assessments and risk control options, including setting of safety distances for bunkering, linked to the use of low and zero-carbon fuels on-board and impact in ports, developing protocols for safe response through detection and dispersion modelling (both marine and atmospheric), personnel protective equipment and adequate response techniques and equipment.
- The plan for exploitation and dissemination of results will identify adequate business cases and provide roadmap for the deployment of the proposed technology, including plans for scalability, commercialisation, and deployment. Identify and propose opportunities for further market uptake under the Innovation Fund and complementary bunkering needs under CEF AFIF.
- Developing material for training, reskilling, and upskilling of seafarers to use the developed solutions.
- In addition to full scale demonstrators, proposals must also conduct 3 replication studies on the scalability and transferability of the proposed solutions in different ship types. These studies must demonstrate the viability of the new tools, methods and process required for the integration of the proposed solutions. The scope should include not just storage tanks, engines, or injection mechanisms but also virtual prototyping and hardware-in-the-loop testing for verification, especially for the (safety) automation systems. Impact on factors like load-steps, load acceptance, and vibrations must be also included, as to facilitate the design of high-performing, maintainable, and safe vessels must be taken into consideration.
- Development of relevant on-board after-treatment of specific pollutants sourced from low and zero-emission fuels (e.g. ammonia slip and possibly N_2O for ammonia or formaldehyde for methanol). Costs relating to on-board CCS and/or CCUS incurred within the project will not be eligible for EU funding. These solutions will not improve the score of the proposal during the evaluation, but proposals including these technologies will not be excluded.
- Proposals must justify their contribution to the EU added value creation and strategic autonomy throughout the supply and value chain, including competitiveness of the EU waterborne industry, enhancement of the EU's R&I capacity, technological know-how

capabilities and human capital, and resilience of the EU industrial and manufacturing base, in line with the EU's Economic Security Strategy (including Research Security).

Additionally, proposals are invited to prove the utilization of big data and data science technologies to determine real-world references regarding ship performance, environmental impacts and maintenance needs of ships operating on low and zero-carbon fuels.

HORIZON-CL5-2025-D5-10: Demonstration of Battery Energy storage systems in Existing and New Vessels via Novel Energy Storage and Ship Design Concepts (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	IA
Technology Readiness Level	Activities are expected to achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcomes: Project outputs and results are expected to contribute to all the following expected outcomes:

- Demonstrate a long-distance autonomy of at least 120 nm for 400-5000 GWT maritime vessels or 86-135 m inland river vessels, using batteries as the primary energy source.
- Demonstrate innovative solutions in energy storage concepts, energy efficiency or rapid in-route charging.
- Increase the connectivity between islands and their connections to mainland.
- Improve the lifetime and safe use of batteries in waterborne transport by addressing the degradation and failure modes associated with unique maritime operating conditions.

Scope: Batteries are highly efficient carriers of renewable energy and their increased utilization in various shipping applications enables the decarbonization and depollution of waterborne transport. Full battery-electrification is already being demonstrated for small and medium-scale vessels. This call aims to increase the range of fully-battery-electric operation of seagoing vessels on this range of size.

Projects are expected to address all of the following aspects:

- Full scale demonstration of battery-electric operation of seagoing vessels in the range of 400-5000 GWT or inland river vessels in the range 86–135 m, with a 50% increase in the vessel operating range with battery as the primary source of propulsion with respect to a 2024 state-of-the-art full electric baseline. The solutions should support an operation range of at least 120 nm (or equivalent) and be applicable to representative operating conditions of the chosen ship (maritime ships: appropriate sea states, inland waterway ship: upstream and downstream operation). The proposal should indicate if they will address a maritime ship or an inland waterway ship. The best scoring proposal of each ship type will be supported provided that they reach all necessary thresholds. Project proposals must clearly indicate the baseline range, the expected range as an outcome of this project, and the corresponding operating conditions. The following baselines may be considered for container ships, ferries, and research vessels, respectively, but any other representative baseline may also be chosen for a different application.
  - Containership: Yara Birkeland, electric range 10 nm with 7 MWh batteries at 6 kn
  - Ferry: e-Ferry Ellen, electric range 22 nm with 4 MWh batteries at 13 kn
  - Research vessel: FLEXSHIP project, 80 nm with 1 MWh battery at 5 kn
- Innovative measures for range extension, which should go beyond the simple scaling up of existing commercial battery systems to increase the range. Solutions must include one or more of the following:
  - New onboard energy storage system concepts enabling high energy-densities suitable for different waterborne applications
  - Innovative onboard energy efficiency measures including but not limited to, thermal management, high voltage electrical components, energy management and energy modelling for optimal operation including weather routing, integration of photovoltaic panels, and wind-assisted propulsion, and improved vessel hydrodynamic efficiency
  - Concepts for rapid in-route charging or battery replenishment while maintaining desired operating schedules. Fast charging and OPS concepts should adhere to the IEC/IEEE standards which are under development, and the consortium is expected to liaise with the technical committee in IEC/IEEE and converge technical solution with standard under development. Other solutions enabling intermittent in-route power transfer to vessels may also be demonstrated.
- Development of guidelines/recommendations for the safety assessment of the novel installations based on field testing. This should build on established safety guidelines and requirements such as the EMSA *Guidance on the Safety of Battery Energy Storage Systems* and CESNI *requirements for fixed and swappable batteries on inland vessels*, as applicable, and contribute to their applicability to a wider scope of novel electrification solutions. Furthermore, recommendations for improving the guidelines and extending them to the demonstrated new battery installation solutions should be presented. Regulatory aspects for the pertinent safety-critical ship systems should be also addressed.

- Replication case studies showing the applicability of the developed solution across at least two other waterborne applications via testing and large-scale experimental validation of developed concepts under emulated conditions. The studies should explain the opportunities and limitations of the developed solution, including the conditions under which the target of 50% range extension can be achieved, and provide an outlook of how this can lead to further range extension in the future.
- The plan for exploitation and dissemination of results will identify adequate business cases and provide roadmap for the deployment of the proposed technology, including plans for scalability, commercialisation and deployment. Identify and propose opportunities for further market uptake under the Innovation Fund and complementary bunkering needs under CEF AFIF.
- Developing material for training, reskilling and upskilling of seafarers to use the developed solutions.
- Proposals must justify their contribution to the EU added value creation and strategic autonomy throughout the supply and value chain, including competitiveness of the EU waterborne industry, enhancement of the EU's R&I capacity, technological know-how capabilities and human capital, and resilience of the EU industrial and manufacturing base, in line with the EU's Economic Security Strategy (including Research Security).

HORIZON-CL5-2025-D5-11: Real-time, adaptative and innovative energy management solutions to optimize fuel consumption and lower emissions pollutants in waterborne transport (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	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).

Technology Readiness Level	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	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)[47].

Expected Outcomes: Project's results are expected to contribute to some of the following outcomes:

- Leveraging on Artificial Intelligence (AI), Machine Learning (ML) and improved instrumentation, as well as on monitoring and control systems to optimize ship operations, while integrating new fuel types, power conversion systems, propulsion and heat systems, wind-assisted propulsion, and other energy efficiency solutions.
- Improve supervision, forecasting, and real-time control of the full spectrum and complexity of ship energy needs and flows, according to the variety of operation profiles (i.e., ship energy dynamics).
- Development of adaptable real-time optimization strategies to accommodate expected and unforeseen operational conditions.
- Improved calibration and certification of sensing systems to support the enforcement of Greenhouse Gas (GHG) emissions reduction, as well as SOx and NOx emissions regulatory framework, both at a European level (e.g., Sulphur Directive) and international (e.g., MARPOL Annex VI), as well as any other relevant harmful emissions, leading towards common operational procedures, methodologies and reporting.
- Improved ship design concepts including lessons learnt from energy efficiency optimization, considering various parameters that influence ship performance under diverse operational conditions (e.g., wave characteristics, wind strength, hull biofouling growth rate).

Scope:

[47] 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

Energy Management Systems (EMS) have the potential through adaptive control, ML and AI to optimise energy demand and minimise harmful emissions. This paradigm shift is also poised to increase vessel efficiency through pioneering assessments and optimized integration indicatively of groundbreaking power conversion and energy storage systems, Waste Heat Recovery (WHR) systems, machinery prognostics and system simulations, variable speed electric motors, and both centralized and modular energy micro-grid architectures. In parallel, such advancements allow for real-time exhaust gas monitoring, including particulates, SOx, NOx and GHG emissions, which could be integrated into the overall monitoring and adaptive control.

Projects are expected to address all of the following aspects:

- Development, adaptation and integration of real-time monitoring solutions for continuous mapping of ship operating profiles, energy flows, Greenhouse Gas (GHG) emissions, as well as SOx, NOx and other polluting emissions (e.g., emissions from methane slip), including the assessment of potential ammonia environmental footprint.

- Development of advanced monitoring, supervision and forecasting models, by capitalizing on Artificial Intelligence (AI) and Machine Learning (ML) capacities for real-time data analysis and feedback, considering both internal and external data sources; comprehensive machine learning models should enable intelligent vessel performance monitoring and supervision, vessel operation optimisation and planning.

- Design of centralised or modular ship energy architecture, including micro-grid architectures, applicable to a variety of commercial ship types, and adaptive energy management systems to improve the overall vessel energy efficiency, through energy demand reduction and energy supply efficiency.

- Showcase the flexibility of the adaptive energy management system using simulation methods for different vessels having various propulsion system types, operating in a wide range of environmental conditions.

- Assessment of design, including retrofitting, and operational measures and controls by focusing on three (3) case studies, i.e., Inland Waterways Transportation - IWT, Shorth Sea Shipping – SSS and Deep Sea Shipping - DSS, aiming at maximizing vessel efficiency, in the context of designing for efficiency.

- Development and integration of technologies for real-time measurement of emission and energy efficiency parameters (e.g., direct real-time GHG emission measurements in the exhaust fumes, or combustion parameters in the combustion chamber with wireless signal transmission to optimise combustion).

HORIZON-CL5-2025-D5-12: Novel Holistic Intelligent Tools for Variable Retrofit and Decarbonized Scenarios (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

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

- Novel holistic intelligent tool for variable retrofit scenarios and new operational modes will be developed and then demonstrated by the application to a to-be-refitted ship test case;
- Overcome the limits of current generation of design tool, that do not account for the *interferences* and *mutual influences* among the different retrofit systems installed on board;
- Contribution to the retrofitting of existing aging fleets in the EU;
- Increased competitiveness of European shipyards, marine equipment providers and repair yards in the maritime green technology sector through the development of cost-effective solutions that support ship-owners in making the European fleet climate neutral and still competitive;
- Accelerate regulatory approval processes, build on best practice guidance, and enable easy-to-customize strategies for retrofitting by reducing the commercial risk of deployment for ship owners.

Scope:

In the quest to get energy reductions from retrofitting, new design requirements and constraints are emerging, e.g. due to the introduction of new low-carbon fuels, either gaseous (i.e. biogases, hydrogen and synthetic methane) or liquid (i.e. liquid biofuels, ammonia and synthetic liquid hydrocarbon fuels), and new added propulsion systems (e.g. wind assisted systems). Furthermore, other technical measures are not yet “standardized” for retrofitting existing ships, due to other difficulties or high costs.

There is a lack of design/retrofitting experience too in applying these new solutions. A practical example is the space rearrangement in the electrification of the ship, including the installation of heavy battery sets, a solution that uses space: but changing ship's volume and weight distribution along the beam might have a strong effect on the seakeeping performances.

The realization of *ad-hoc* web tools and guidelines to help with the retrofit task is currently under development, based on the limited number of new small-scale demonstrators within ongoing projects (e.g., *Green Marine*, *RETROFIT55*, etc.). Current approaches however, even if the final results have not been delivered yet, are considering the retrofit problem in a silo-based mode, that is with single technology interventions, leading to difficulties in achieving overall optimal goals, therefore *with a limited impact* on the transition to zero-emission waterborne. The simplified strategies are indeed not accounting for the *interferences* and *mutual influences* among the different retrofit systems installed on board (i.e. available space and payload, safety constraints, electrical constraints, etc.): in other terms, they are not considering the *global problem* of retrofitting. The solution of this problem is a major objective of this call.

Furthermore, in the short and medium term we are and will be observing multiple ongoing regulatory processes (by IMO, EU, UNFCCC, ESTRIN) developing frameworks and standards that will shape shipping in the next decades. This further element of variability, i.e. the uncertainty in decarbonization ambitions as well as on the variability in cost and availability of carbon-neutral fuels, not considered yet in the current approaches, claim for a large effort for new holistic retrofit intelligent design tools for exploring multidisciplinary solutions in variable decarbonization scenarios.

Innovative holistic intelligent design tools, with a multi-objective strategy and AI simulators, have to be developed rapidly and tested if we want to significantly contribute to the transition to zero-emission waterborne transport, and these has to be done by integrating the many sectors involved in the design.

Projects must address all of the following aspects:

- The development of a novel intelligent design digital tool capable of a full integration of decarbonizing technologies (e.g. alternative fuel propulsion systems, auxiliary propulsion systems, renewable energy sources, etc.) and capable of being used for retrofit concepts.

- The design digital tool must also have the capability of considering together multiple decarbonization solutions for operating vessels, accounting for reciprocal influences.
- Retrofit configurations might include changes in operational modes (e.g. slow steaming, weather routing, etc.).
- The design tool will include a life-cycle perspective from design to scrapping.
- Preliminary (intermediate) validation of the design tool by testing at model scale original versus refitted ship solution.

- Final demonstration, applying the tool in 6 virtual demonstrations, one for each one of the six ship types detailed in the Strategic Research and Innovation Agenda of the Zero-Emission Waterborne Transport Partnership, considering together multiple decarbonization solutions and producing final optimized refitted designs to be tested in operational environment conditions with a given operational profile.

HORIZON-CL5-2025-D5-13: Flexible, modular, and mobile solutions for Onshore Power Supply and the provision of fast charging batteries using renewable energies (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	IA
Technology Readiness Level	Activities are expected to achieve TRL 8 by the end of the project – s General Annex B.

Expected Outcome: Project outputs and results are expected to contribute to at least two of the following expected outcomes:

- Ship and port operators will benefit from innovative solutions for OPS Low/High Voltage for ships at shore and offshore, beyond the deployment actions taking place to meet the requirements of FuelEU Maritime and AFIR set by 2030, towards the policy goals set by 2050.

- Ship and port operators will have standards, protocols and/or solutions aiming to bridge the gaps identified.

- Short-Sea Shipping and cabotage operators will benefit from automated management and connection systems.

- The OPS solutions will take into account the special features of the different ship types and services and port environments, with an special consideration to safety explosive atmospheres and dangerous zones.

- The port logistics will benefit from OPS solutions in areas other than the terminals, including offshore areas (eg. anchorage), demonstrated in different port environments aiming to provide a set of solutions that will allow different ports with different conditions (physical and operational) to optimize OPS.

- Ship operators and grid managers will have solutions to prevent electrical failures and for earthing monitoring.

Scope: OPS solutions currently available in the market, while conforming to standards, have gaps in terms of flexibility, modularity tin particular regarding the expected future demand in terminals with a high turnover of diverse maritime traffic served. The solutions developed should not be tailored, so they can be used for several types of vessels. The projects should take into account the special features of the different ship types and services, like the safety part for tanker and chemicals traffic where connectivity in complex environments is an issue.

Following Fitfor55 OPS requirements in AFIR and FuelEU, the Onshore Power Supply new products are being developed, including High-Voltage OPS systems are developed within a framework of robust standardization. In addition, further research is needed for the mature, flexible and safe provision of OPS at anchorage and in places other than the terminals through technologies other than barges, applicable to a wide range of ports with different geographies and conditions.

The development of solutions to simultaneously provide OPS, fast battery charging as well as loading operations needs further standardization and dedicated protocols. Standardization of fast battery charging is underway, therefore. relevant research for fast battery charging beyond the current or soon to be adopted standards (eg. IEC/EEE 80005-4) should be explored in the project.

Projects must address all the following aspects:

- Develop and test innovative modular and scalable solutions for Low/High Voltage that will allow for OPS for ships at shore and offshore. Justify how these solutions will have meaningful impact for application after 2030, when ports are supposed to have in place OPS installations ready according to the AFIR and FuelEU Maritime requirements

- Identify remaining gaps in standardization for the solutions developed and define recommendations for standards, protocols and/or solutions at least for safe fast battery charging, OPS and load/unload cargo operations simultaneously and OPS at anchorage.

- Research into the specific challenges of deploying and replicating OPS at anchorage through technologies other than barges in EU ports and solutions to overcome these challenges, including scalability challenges.

- Identification of other emerging research needs in OPS and battery charging installations in order to achieve the goals set by 2050.

- Integration of artificial intelligence for black-out prevention. Identification of back-up systems and strategies for shore-power restoration (e.g., microgrid arrangement, integration of electrical energy storage). The integration of the solutions on the Energy

Management System of the grid supplying the electricity and the one receiving it must also be analysed.

- Development of earthing protection solutions through monitoring of the grounding resistance to predict failure.

- All solutions must align with the optimization of onboard High Voltage transformers, automation of onboard connection systems, optimization of onboard OPS switchboard operation, and onboard safety monitoring systems and blackout prevention/mitigation systems to synchronize process and the communication between ship and shore.

HORIZON-CL5-2025-D5-14: Optimal integrated onboard renewable energy solutions, by considering wind-powered and hull performance technologies (ZEWT Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcomes: Project's results are expected to contribute to the following expected outcomes:

- Standardised framework to provide certainty to the claims regarding fuel, Greenhouse Gas (GHG) and other polluting emission reduction by Wind-Assisted Propulsion (WAP) systems, strengthening the implementation of the FuelEU Maritime Regulation.
- Explore and establish uniform rules, regulations, assessment criteria, and sea-trial procedures for WAP solutions.
- Support the standarisation efforts to implement the IMO Life-Cycle Assessment (LCA) guidelines, facilitating the market uptake of WAP systems.
- Facilitate the retrofitting of WAP systems into existing vessels in the coming decade.

- Address concerns about the safety and operational impacts on ships, port and other land infrastructure, as well as the lack of market confidence in the technology.

Scope:

WAP systems (e.g., rotor sails, rigid wing sails, soft wing sails, ventilated foil system, etc.) have gained significant attention as means of reducing ship fuel consumption, and GHG and other emissions, while they are also considered as primary means of propulsion for future newbuilt cases. Several ongoing EU-funded projects are already working on WAP systems with focus on holistic optimised ship design, control, and operation, including changes in conventional propeller propulsion, and focused on Deep Sea Shipping (DSS). However, there are still a variety of barriers and challenges that need to be addressed; the main challenges are to provide certainty on emission saving performance, define standardisation, while also facilitating WAP retrofitting.

Projects are expected to address all of the following aspects:

- Demonstration of at least one full scale WAP solution and its management and monitoring on-board
- Develop a holistic framework for the design optimisation for wind-assisted propulsion, either as a means of enhanced energy efficiency, or primary propulsion solution; the framework should work as design tools to facilitate the industry uptake of WAP technologies by introducing tailor-made solutions for various ship types, based on their operational profiles.
- Develop a methodology for advanced monitoring of energy consumption, energy savings, GHG and other polluting emissions, by capitalising on sensor and digitalisation technologies; methodology should cover various types WAP and be applicable for all types of ships and operations.
- Capitalise on simulations and digital tools and examine possible combinations and interaction with energy efficiency solutions such as – but not limited to – hull performance technologies, aiming for renewable energy-powered vessels.
- Assessment of environmental and wider benefits, including reduced emissions of air and water pollutants, as well as underwater radiated noise, as well as cost-effectiveness for WAP solutions or combinations.
- Assessment of environmental and wider benefits, including reduced emissions of air and water pollutants, and underwater noise, as well as cost-effectiveness for either standalone WAP solutions and combinations with other energy efficiency measures.
- Focus on safety and operational aspects, for addressing any technical and operational challenges that may arise from the introduction of WAP systems – and possible combinations with other energy efficiency solutions – for ships and ports, including other land infrastructure.
- Addressing scalability and adaptability issues to the existing fleet, such as efforts to promote the standardisation of the different solutions, and application of the solution considering the real environmental conditions and the impact of climate change in wind patterns.

- Examine a variety of business cases and propose a number of market measures to address the lack of market confidence in WAP solutions and the uptake of such systems in the maritime industry.

HORIZON-CL5-2025-D5-15: Innovative Earth observations services in support of maritime litter detection and ship source pollution policies

(Joint topic with cluster 4 - to be implemented in the cluster 4 work programme)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action
Eligibility conditions	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) Participation of the JRC as member of the consortium permitted: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – The reference TRL definition is the ISO 16290:2013 applicable to the space sector.

Expected Outcomes: Project's results are expected to contribute to the following expected outcomes:

- National maritime authorities and enforcement bodies will benefit from improved detection services to fulfil the requirements of the Ship Sourced Pollution Directive, ultimately resulting in a higher environmental protection of sea waters and preservation of marine ecosystems;

- Increased accuracy from the developed solutions will allow more efficient and quick responses to potential spill incidents.

Scope:

The MARPOL convention adopted at the IMO level regulates the release at sea of substances originating from ships, be it from the ship's operation or cargo operations. The Ship Source Pollution Directive adopted in 2005 seeks to strengthen the enforcement in the EU of the

prohibition of release at sea of substances under Annex I and II of the MARPOL convention. Currently, high-resolution satellite imagery of the ocean surface is used to monitor and detect potential spills, notably through the CleanSeaNet service, offered by the European Maritime Safety Agency.

The revision of the Directive that will expand its scope to discharges in the water under all MARPOL annexes. Further research is needed to adapt the current monitoring systems to the accurate detection of the substances included under the revised scope of the SSPD as the technologies may not be available or accurate enough.

The objective of this topic is to support R&I activities developing advanced technological solutions, that will allow to enhance the service provided to Member States for the detection of potential spills and identification of potential polluters.

R&I activities should complement what is currently being done by EMSA, along CleanSeaNet and the Copernicus maritime surveillance service. Moreover, the Copernicus Security Services Strategic Research Agenda (CSS-SRA) provides, on a yearly basis, an overview of R&D activities, as well as proposed actions based on latest developments. Applicants are invited to consult the corresponding additional requirements and information based on the CSS-SRA 2024 exercise to develop their proposal.

The project must address the following points:

- Development and demonstration of space sensors, including the assessment of their operational boundaries and associated technical confidence levels, for the following use cases:
    - Estimation of oil spill volume and thickness, in conjunction with the identification of oil types using for instance oil spectral signatures;
    - Detection of oil spills in sea ice conditions;
    - Detection and identification of chemical products on the sea surface (MARPOL Annex II);
    - Detection and identification of sewage on the sea surface (MARPOL Annex IV);
    - Detection and identification of garbage on the sea surface (MARPOL Annex V);
    - Monitoring of single-vessel methane emissions (MARPOL Annex VI);
    - Detection and Identification of the possible polluter using vessel unique spectral signature.
- Design and improvement of use of artificial intelligence for the identification of spills, sewage and garbage on the sea surface and their characteristics.

The IP generated by the projects should not prevent the free access and use of the technology developed by the European Commission and its Agencies.

Transport-related health and environment

HORIZON-CL5-2025-D5-16: Real time monitoring of regulated and non-regulated emissions for all types of vessels in order to enforce emission limits in waterfront cities (topic in collaboration with the Zero-Emission Waterborne partnership and the Cities Ocean Mission)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility conditions	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).
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected outcomes: To support the Zero Pollution Action Plan and the Smart and Sustainable Mobility Strategy, project results are expected to contribute to all of the following expected outcomes:

- Real time demonstration of on-board tamper-proof and remote measurement techniques for a wide range of pollutants (including pollutants from alternative fuels and non -regulated pollutants) from vessel emissions, under dynamic engine loads, used during normal operation of all ship types (including port service vessels), allowing shipowners to measure the emissions during operation and contributing to the current monitoring and enforcing activities of public authorities, such as port and maritime authorities and with the potential to be used for future compliance monitoring and -if possible- prosecution, beyond fuel sulphur content and including low or zero carbon fuels or aftertreatment technologies.

- Pilot testing in 6 different TEN-T ports, (of which 2 Core and 2 Comprehensive sea ports, covering all the four sea basins of the Black, Mediterranean, N. Atlantic and Baltic Seas). and 2 inland ports (1 in the Rhine and 1 in the Danube basin) with the aim of demonstrating scalability and replicability for other ports with similar complex environments.

- Identification of risk areas for potential violations to emission limits

- Development of harmonized coastal- and open sea as well as inland waterway monitoring methods with the potential to be used for future compliance monitoring and -if possible- prosecution, further to fuel sulphur content legislation and including low or zero carbon fuels or aftertreatment technologies

- Development of an automatic reporting and verification system solution that helps shipping companies to comply with current and future regulation and is also of help to various maritime, inland waterway and port administrations to monitor and control the actual ship emissions derived from the data exchanged.

- Identification of in-the-field releases of harmful substances which are currently not controlled by regulations and excessive releases of substances already controlled in open seas and in-port activities/

- Innovative technologies and systems to monitor, measure and identify the source of pollution in ports beyond vessels, including other transport modes, port operations and industries active in the port environment are made available for public authorities.

- Support of local, regional, national and international emissions reduction and air quality plans by providing real-world emission information and measuring the actual impact of control measures and strategies on concentrations and/or deposition of pollutants.

- Establishment of broadly accepted methods for measuring and calculating real sailing emissions of a ship (e.g. comparable to PEMS method for road vehicles).

- Contribution to the delivery of better emission factors for emissions inventories and projections, especially for s harmful substances and fuel mixtures for which little knowledge exists today and ultimately contributing to the establishment of a broadly accepted method for measuring and calculating real sailing emissions of a ship.

- Recommendations for improved certification and testing to better cover real world situations.

- Indicative Assessment of the health impact (both the nature, seriousness and number of people at risk) of the measured pollutants from shipping at ports or at the nearby urban environment as well as the particular impact of water fouling pollutants on marine life ecosystems

Scope:

The IMO's 2023 GHG Strategy targets net-zero emissions from international shipping by 2050, with interim goals for 2030 and 2040. Measures include adopting zero-emission fuels like methanol and ammonia. In the EU, initiatives like FuelEU Maritime and ETS inclusion will drive this transition. Regulations address harmful emissions like sulphur and nitrogen oxides, with Tier III NOx limits enforced. Discussions also focus on Black Carbon emissions in the Arctic and health impacts of ultrafine particles.

Recent evidence from research and monitoring projects has shown that new fuels being considered and emission control technologies used on-board vessels may still result to emissions of harmful pollutants that are not sufficiently controlled today. In some cases, unexpected side effects of emission abatement may arise which might require regulatory action in the future.[48].

Further to such undesired releases, there is a need to ensure that vessels comply with regulations in force, in coastal areas, at open sea, and in inland waterways. In the past, projects under call LC-MG-1-1-2018 in H2020 showed that remote measurement of SO_x emissions using stationary or mobile techniques can significantly increase the cost-effectiveness of compliance monitoring. There is the need to explore whether remote or on-board techniques can be extended to the monitoring of additional pollutants, such as CH_4, NO_x, N_2O, NH_3, UFP, BC, formaldehyde, PM, as well as the Particle Number (PN) and to provide internationally harmonized methods and reporting procedures where such measurements can be used within an enhanced compliance monitoring framework of the future. These methods should also have the potential to be used as evidence for law enforcement to enable independent prosecution of violations. Further, there is a need to develop engine testing procedures to make sure these better represent operational patterns in order for the emission values from test cycles to represent real emissions.

Limited surveillance measurements at open seas show a different compliance (lower compliance) behaviour for sulphur emissions compared to measurements in coastal regions. Therefore, it is important to identify risk areas for violations and to establish techniques for monitoring also in those regions, such as SECAs and NECAs. Moreover, since for a legal sanctioning of a violation, only evidence obtained by an on-board inspection is admissible, it is of great importance to develop harmonized/standardized monitoring methods that have the potential to be used as evidence for sanctioning in the future.

Assessment of the real-world performance of emission control, in particular for Tier III vessels, is therefore required to make sure that current NOx regulations achieve and sustain

[48] For example, evidence shows that the introduced Tiers may not be effective in controlling NOx emissions in real vessel operation, scrubbers may result in the formation of new ultra-fine particles, ammonia combustion potentially leads to the formation of nitrous oxide and ammonia slip, methanol combustion may lead to the production of formaldehyde, LNG may result in the slip of methane, etc. Obviously, any strategy targeting the control of GHG or air pollutants should not result in negative side-effects such as the release of harmful pollutants which are today not covered by regulations.

the emission reductions that these are designed for. Further, certification testing should be modified to better address real world conditions. Moreover, potential ammonia slip from urea consumption needs to be identified, and N_2O emission levels determined to ensure that GHG reduction efforts are not thwarted.

In addition, no established method for identifying NOx emissions that exceed existing standards under real sailing operation is currently in place. Based on different remote or on-board measurement techniques, harmonized methods and reporting procedures to identify exceedances of expected emission levels needs to be designed and put in action, at least for informative reasons – as no enforcement of low NOx under real operation is currently in place.

With CH_4 being a potent GHG, any uncontrolled releases from LNG powered vessels significantly compromise any lower carbon benefits of the LNG as a fuel. Moreover, although boil-off gas (BOG) should be reliquefied or used on-board, records of BOG release to the atmosphere have been reported. The extent of any remaining current problem needs to be identified and measurements on methane slip from actual vessels need to identify the extent of emissions, considering potential needs for methane emission limits (for the engines as well as for the fuel storage onboard and the bunkering process). The problem with methane slip will also remain with the use of bio-methane as fuel.

New fuels are considered in the effort to decarbonize shipping, with the most prominent being ammonia (NH_3), methanol (MeOH) and hydrogen. There is currently limited evidence on new pollution dimensions induced by such fuels, including ultrafine particles of non-carbonaceous origin, N_2O and NH_3 emissions, NPAH, Formaldehyde PM, NOx, etc. Measurements on actual marine engines and vessels using such fuels need to provide new evidence in the pool of data forming so that early measures are taken before such new fuels become widespread in actual use, in case such new emissions prove to be at a level that constitute health hazards or environmental risks. Zero carbon fuels like NH_3 and H_2, as well as dual-fuel engines and CO_2 capture onboard require different remote measurement methods, since CO_2 is no longer a stable and dominant reference gas in the exhaust plume. Alternative options in sensing and calculation method need to be introduced.

Ports are complex environments, with a variety of ships including novel designs, something which represent a challenge to the development of standardized technologies that could collect and assess in real time air emissions data from these ships calling at ports in order to enforce emission limits and to certify this information for enforcement purposes. At the same time emissions in the port originate from other sources like port operations (e.g. cargo handling, towage, storage and bunkering of fuels) or even other industrial activities (directly or indirectly linked to transport, e.g. fisheries) that take place within the port area. In addition, ports are often located adjacent industrial areas. It is therefore important to have an accurate and to the extent possible real time picture of the type, source and intensity of emissions generated in and around a port area.

Demonstration shall be undertaken within a real environment. In the collection and analysis of remote as well as static sensing data for the monitoring of emissions and air pollutants, the

accuracy of the sensors and the quality and verifiability of the data obtained are of particular importance. Potential risks and problems in data collection and sensor technology, in particular as regards the identification of the source of the pollution, should be analysed in detail. A verifiable methodology is also required for processing and interpreting the data in the next step. Issues such as access to data, data storage and associated security aspects (including the assessment of cyber security of interoperable systems) should be fully considered.

To address all the aforementioned issues, proposals are required to undertake all the following R&I activities:

1. Identify risk areas and demonstrate coastal and open sea monitoring techniques for at least NOx, BC, N_2O, UFP, NH_3, CH_4,, PM as well as PN (or any other related pollutants), during normal operation of ships which includes dynamic engine loads and suitable for zero carbon fuels, dual-fuel engines and carbon capture. All the emission measurements have to be integrated through static and remote sensing in order to share data.

2. Demonstration of the developed technologies in 4 different TEN-T ports, (of which 2 Core and 2 Comprehensive ports, covering all the four sea basins of the Black, Mediterranean, N. Atlantic and Baltic Seas), as well as 2 inland waterway ports (1 in the Rhine and 1 in the Danube basin). Sufficient efforts should be anticipated in each port to ensure that outcome is representative and can be replicated to other ports.

3. Identify, differentiate and measure in real time at or near possible sources of emissions (e.g. individual vessel, specific port operations, industrial installations within and very close to the port area) under complex (geographical, layout, mixed space uses and other) conditions and variable weather conditions.

4. Development of a methodology for assessing the standard pollution within the port area that includes emissions from all transport modes, port operations and industries located in the port area.

5. IAssess the impact of emissions in ports in cities and propose mitigating measures and plans for municipalities and port authorities, including ports in which municipalities are not directly involved in the management of port authorities and terminals.

6. Development of Real-Time Decision Support Systems (RT DSS) for ships, integrated with the PRF, onboard ship operations, ship operators to look into data collected to enable port and maritime authorities to make decisions about rebates.

7. Development of harmonized monitoring techniques and an automatic reporting and verification system solution helping shipowners to comply with current and future EU and international regulation as well as public authorities to monitor and control emissions from the data exchanged.

8. Harmonize/standardize monitoring techniques and reporting with the potential to be used for legal prosecution; develop recommendations for improved certification and testing for real world situations.

9. Increase evidence to feed pool of data for regulated and non-regulated pollutants from vessels.

10. Identify pollutants from new fuels used for shipping decarbonization.

11. Develop protocol(s) for the measurement of BC, UFP, and PN from vessels.

12. Develop engine testing methods to better mimic real-world emissions and propose a vessel grading system methodology with respect to its emissions comparable to EURO classification of road vehicles.

13. Characterize the measured pollutants (including water-fouling pollutants) and develop a risk assessment methodology for their impact on human health and environment.

Proposals should demonstrate how they will engage with authorities and local communities in disseminating results in proportion to their expected impacts. Relevant authorities include the EC, the Bonn Agreement, Helcom, the IMO, and national, regional and local competent authorities etc. while local communities are primarily but not limited to major port cities and coastal areas in the EU.

Proposals are encouraged to explore and develop synergies with previous EU-funded projects such as SCIPPER (H2020), and Green C Ports (CEF), Interreg Clean North Sea Shipping and LIFE CLINSH (CLean Inland SHipping) as well as with relevant activities funded under the Horizon Europe call on “Advanced transport emissions monitoring networks” (HORIZON-CL5-2023-D5-01-18) and activities developing satellite-based measurements (Cluster 4 Destination 5 (Space) and EUSPA), focusing on remaining gaps not covered by these projects. Duplication of activities should be avoided.

Proposals are encouraged to include and consider the fisheries sectors and fishing vessels, considering their potential intersections with the use of alternative fuels in ports when relevant. Consideration of projects such as HORIZON-MISS-2023-OCEAN-01-05 and PPPA-2024-FISHVESSELDEMO may prove beneficial.

This topic is implemented in collaboration with the co-programmed European Partnership on ‘Zero Emission Waterborne Transport’ (ZEWT) and the Cities and Ocean Missions.

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.

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientations** '*Green transition*', '*Digital transition*' and '*A more resilient, competitive, inclusive and democratic Europe*'.

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *'Multimodal systems and services for climate-neutral, smart and safe mobility'.*

The main impacts to be generated by topics under this Destination are:

Connected, Cooperative and Automated Mobility (CCAM)

1. Safe, shared, inclusive, affordable, attractive and accessible door-to-door mobility for people and goods, including freight services and last-mile deliveries, in all weather conditions, seamlessly integrated with various transportation modes to ensure interoperability and full integration of CCAM solutions into the existing transport ecosystem.

2. Resilient, climate neutral, and sustainable mobility solutions with a reduced carbon footprint leading to greener, less congested, cost-effective and more demand-responsive transport everywhere.

3. Smart mobility services based on user-centric and explainable technologies and services, including digital technologies, advanced satellite navigation services, and smart traffic management (Ai enabled when appropriate), considering the diverse needs and behaviours of categories of end-users.

4. Improvement of road safety thanks to the progressive transition of road traffic towards automation

Multimodal and sustainable transport systems for passengers and goods

1. Advanced knowledge base and solutions for climate neutral and resilient infrastructure.

2. More efficient, sustainable, safe and competitive infrastructure construction, maintenance, inspection and monitoring in a "whole life cycle" approach.

3. Existing and new transport infrastructure is designed/adapted to support deployment of new technologies and fuels in view of improving its performance, user experience and safety, support seamless and efficient multimodality and limit transport related emissions.

4. Reduced emissions and increased efficiency and competitiveness of long-haul and regional freight transport and logistics, including the supply chain optimisation.

Safety and resilience

- Drastic reduction in serious injuries and fatalities in road crashes involving cyclists, pedestrians and users of micro-mobility devices.
- Predictive framework is established using AI and big data for transport safety.
- Optimised Human-technology interaction that minimises confusion, distraction and thus collision risks.
- Enhanced aviation safety under adverse weather conditions.

Connected, Cooperative and Automated Mobility (CCAM)

HORIZON-CL5-2025-D6-01-SRP: Advancing remote operations as an enabler of sustainable and smart mobility of people and goods: operational and societal needs (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. Comprehensive set of principles and guidelines for remote operations that clarify the operational complexities (e.g. safety, liability, privacy, certification and training, interoperability, cross-border operations), and establish a standardised approach to extend the ODD of CCAM solutions.
2. Infrastructure prerequisites, particularly in technology and communications, that are critical for the successful implementation of remote operation capabilities, outlining the technical standards and investments necessary for seamless integration with current transport systems.

3. Safety validation methodologies extended to remote operations favouring responsiveness and trust of road users in such CCAM systems.

4. Economic feasibility study of at least two business cases for remote operations extending the ODD of CCAM solutions, analysing the economic costs and benefits, market potential, and scalability factors, and providing a clear value proposition for public or private stakeholders for each use case.

5. Understanding human factors, legal requirements and working conditions for remote operators, addressing cognitive load, fatigue and stress, ergonomic considerations, and the identification of essential skills. Establishment of key conditions for job quality, safety, up-to-date competence, and societal responsiveness of working conditions in diverse cultural contexts.

6. Analyse and develop supporting actions to advance the societal readiness of remote operations by ensuring CCAM aligns with societal needs[49].

7. Policy and governance recommendations in view of establishing new or updating existing legislation to cover remote operations, e.g., through clear descriptions of stakeholder roles and responsibilities that may vary for different types of remote operations.

8. Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake and building trust in results and outcomes.

Scope: This call aims at exploring the operational and societal conditions and prerequisites for extending the operational design domain (ODD) of CCAM solutions through remote operations. Here "remote operations" is to be understood as the remote monitoring, assisting, and operating the Automated Driving System (ADS) by a person located externally. The vehicle operates with a high degree of automation (SAE Level 4), but a human operator can monitor its actions and surroundings remotely and intervene, if needed. Intervention ranges from providing strategic guidance and tactical commands to determining vehicle manoeuvres and taking over control in scenarios that include, but are not limited to, emergency responses, system malfunctions, or complex navigational challenges unforeseen by the CCAM system.

The call invites proposals to explore use cases[50] that should focus on remote operation on public roads, dealing with the transport of people, the transport of goods and/or their combination. These use-cases can be situated in the following settings: urban, rural, and/ or confined areas.

- Transport of people: use cases that enhance public transport services (e.g., by fleets of remotely operated shared vehicles) improving accessibility and mobility for diverse populations.

[49] Reflecting upon the four dimensions of Responsible Research and Innovation (RRI) namely reflection, inclusion, anticipation, and responsiveness. See Horizon Europe Guidebook.
[50] A minimum number of cases could be included in upcoming version.

- Transport of goods: uses cases that optimise logistics (e.g. remotely operated delivery vehicles in urban environment), improving efficiency and sustainability.

- Combination of people and goods transport: use cases of integrated solutions (e.g., remotely operated vehicles that transport goods during off-peak hours and convert into passenger transport services during peak times) improving vehicle utilisation, while addressing congestion and reducing environmental impact.

For each of these use-cases, operational and societal aspects that would enable remote operation of multiple ADSs should be evaluated in terms of business models, infrastructure needs, safety assurance, legislation, operator's skills, and work cultures, as well as situational awareness of the remote operator.

This topic aims to understand all the different components of the complex 'system-of-systems', combining technological advancements with a focus on human-centred design and societal implications from the start. This will enable to lay the foundation for the development of demonstrator use cases in next phases. These components include technological (e.g. communications, cyber-security, key enabling technologies etc.), and societal aspects (e.g. societal readiness, user-centric design, working conditions, inclusive stakeholder engagement for problem formulation and concepts development, co-creation and co-assessment of deployment and operations, examining unanticipated implications and co-development of solutions, building awareness, trust and support for remote operations, identifying skill gaps and skill transferability of operators as well as training needs and today's offers), as well as other pre-conditions making remote operations feasible (e.g. policy, governance, territorial planning, organisational and legislative requirements).

The safety assurance of remote operation will require the development of a corresponding validation methodology, as the remote operator with the wireless communication system and the related interfaces becomes part of the system to be validated. Proposed actions shall develop the basic principles of such a methodology considering the framework provided by EU 2022/1426, building on the results of the SUNRISE [51] project, and seeking close coordination with actions under HORIZON-CL5-2023-D6-01-02 and HORIZON-CL5-2024-D6-01-02.

This topic is a Societal-Readiness pilot:

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.

[51] Safety assurance framework for connected and automated mobility system, Grant Agreement °101069573.

- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related 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-CL5-2025-D6-02-SRP: Advancing CCAM towards large-scale demonstrations (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. Deliver comprehensive demonstration plans that will ensure elevated public awareness and validated benefits for user and society of connected, cooperative and automated vehicles in-use for people and goods in mixed traffic in various domains across Europe.

2. Ensure engagement from key stakeholders: mobility and transport users, OEMs and suppliers, mobility operators, infrastructure providers, public organisations, social actors and research institutions.

3. Perform feasibility studies for advancing Technology Maturity Levels of a variety of CCAM functionalities in mixed traffic as well as confined areas and logistic terminals.

4. Analyse and develop supporting actions to advance the societal readiness of these large-scale demonstrations by ensuring CCAM aligns with societal needs[52].

5. Deliver consolidated plans providing harmonisation of definitions in the various approval frameworks of testing license procedures across countries and regions on public roads.

6. Responsiveness to a deeper understanding of the needs and concerns of diverse social group involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake and building trust in results and outcomes.

Scope: Despite the progress made in automated technologies over the past years, even today the remaining challenges concerning technical functionality and user responsiveness stay high. To overcome these challenges, this topic focuses on solutions taking automation developments to real life applications by means of large-scale demonstrations and Field Operational Tests in real life conditions[53]. In these, the work addresses the critical areas of validating remaining technical enablers', understanding user and societal needs and concerns, analysing societal implications, advancing societal readiness, for both mobility of people and transport of goods. The tests and demonstrations need to be carried out in mixed traffic on open roads and confined areas where applicable. Interoperability across borders and vehicle brands should be addressed in the demonstrators. Since successful large-scale demonstration activities require strong and early key stakeholder engagement and comprehensive planning, a preparatory action is needed, building, and leveraging on previous and ongoing actions, for the benefit of European competitiveness and leadership.

The action shall leverage on previous and ongoing projects at European and national levels on demonstration activities (e.g. Hi-Drive, SHOW, AWARD, MODI, ULTIMO). The CCAM framework conditions developed by the FAME project (and its successor) shall be considered. This is to optimise the return on investments and create a strong basis for future CCAM large scale demonstration projects to pave the way for a well-coordinated, industry-wide European deployment strategy for CCAM.

The action shall coordinate with the actions related to the Software Defined Vehicle initiative[54]. Proposed actions for this topic are expected to address all of the following aspects:

- Investigate, analyse and define the necessary prerequisites for performing large-scale demonstration projects from the following perspectives:
    - User needs and societal readiness
    - Vehicle technology maturity readiness balanced with the need for Physical and Digital Infrastructures requirements

[52] Reflecting upon the four dimensions of Responsible Research and Innovation (RRI) namely reflection, inclusion, anticipation, and responsiveness. See Horizon Europe Guidebook.
[53] Including Living Labs.
[54] Add ref.

- Approval frameworks of testing licences.

- Prepare for the organisation of large-scale demonstrations of user-oriented and well-integrated CCAM solutions for mobility of people and goods in at least 10 demonstration sites or corridors across Europe. These demonstrations, which will be subject of a later call topic, include:

  - Field Operational Tests are expected to be carried out by hundreds of connected and automated vehicles of multiple brands in 6-10 European countries[55] in variable driving conditions.

  - Living-Lab demonstrations of automated logistics solutions in confined areas, people movers and advanced parking solutions including automated valet parking in at least three EU and/or associated countries during a period of at least six calendar months.

- Address relevant short-, medium- and long-term societal impacts. These include traffic flow and operational efficiency, safety (at the level of the operator, the users and the general public), skill requirements and training of operators, economic and environmental aspects, social equity, public health and land use to enhance the quality of life and provide seamless, clean, safe and reliable transportation for all social groups, while stimulating economic growth.

- Increase societal readiness of CCAM solutions by better aligning with the needs, values, and expectations of diverse social groups (e.g., gender, age, socio-economic situation, geography, vulnerability, disability spectrum, etc.), build multi-stakeholder coalitions for scaling, avoiding and mitigating potential negative implications, while providing positive social, environmental, and economic outcomes.

- Proposed action shall foster the collaboration between public and private stakeholders (e.g., OEMs and suppliers, cities, regions, infrastructure operators, authorities, public transport, freight logistics, research providers, ITS and telecom sector) and social actors, to achieve common objectives and assess societal impacts.

<u>This topic is a Societal-Readiness pilot:</u>

- Proposals must follow the specific requirements [*link to be added to pdf doc*] applying to the Societal readiness pilot, also available in the introduction of this work programme. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.

[55] And/ or Associated Countries, to be determined.

- This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the social-technological interface and enable the design of project objectives with Societal Readiness related activities.

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-CL5-2025-D6-03: Next-generation environment perception for decision-making in real-world CCAM operation: Error-free and secure while improving energy-efficiency, cost-effectiveness, and circularity (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. Availability of validated prototypes of next-generation vehicle and infrastructure-based environment perception technologies for robust, reliable and trustworthy CCAM operation to anticipate and avoid foreseeable risks and unexpected safety-critical situations in complex real-world conditions (e.g., at pedestrian crossings, in construction sites, during interactions with emergency vehicles, etc.);

2. Understanding the degree (and limits) to which automated CCAM perception systems can anticipate, process, and respond to on-site 'early-warnings' (e.g., street design, sounds and smells from the environment, intentions of pedestrians, etc.)

3. Improvement of the energy-efficiency of the sense-think-act systems of CCAM considering the vehicle, the infrastructure, the cloud at-the-edge, while at the same time increasing the performance to guarantee security and error-free reliability; these

developments will contribute to the reduction of the potential climate and environmental footprints of CCAM systems.

4. Standardisation and adoption of modular, reusable, and upgradable software and hardware platforms enabling scalable deployment that can lead to cost reduction and improved affordability, while adopting a circular, eco-design approach based on efficient materials use and reduced waste.

Scope: The initial deployment of Level 4 automated vehicle services in urban and other complex settings has encountered significant challenges in environmental perception and decision-making, leading to occasional remote assistance calls, blockages and accidents that have impacted public trust. At the same time, the increasing computing power demand implies a limited usage of energy and resources to meet sustainability requirements. Thus, emerging large-scale demonstrations of automated vehicles must be accompanied by objective-oriented research aimed at addressing these challenges directly by focusing on:

- Advancements in all steps of the sense-control-act process targeting improvements in performance, accuracy, reliability, and cyber-security for both vehicle- and infrastructure-based smart sensor systems and networks, controllers, and actuators to ensure safety and trustworthiness of CCAM.

- Utilisation of digital enabling technologies such as e.g., AI at-the-edge, machine learning, data spaces with reference scenarios and suitable software architectures.

- Adoption of modular, reusable, and open software platforms supporting the environment perception for CCAM while ensuring transparency of operation, verification, and safety assessment to build trust, with respect to authorities, decision makers and the public via direct performance explainability.

- Improvements in energy efficiency, circularity, and eco-design of the environment perception systems by decreasing potential energy and resource consumption in both production and operation as well as facilitating reusability, reparability and upgradability while further enhancing the performance.

- Reduction of potential costs of environment perception systems through scalability, modularity and standardization making technologies financially viable for widespread implementation.

- Support remote assistance as a steppingstone towards higher levels of autonomy and vehicle automation in wider ODDs.

Solutions shall integrate electronic hardware architectures and software stacks in a co-design approach. Hence, the usage of building blocks from projects of the Software-Defined Vehicle of the Future (SDVoF) initiative under the Chips Joint Undertaking, e.g., on the hardware abstraction layer and SDV middleware and API framework, should be considered. Results from CCAM Cluster 5 projects on AI and machine learning at the edge and complementarities

with projects funded under Horizon Europe Cluster 4 “Digital Industry and Space” should also be considered where appropriate.

As the activities should demonstrate feasibility and their full potential for real-world applications, proposals should foresee exchanges with other relevant EU or national projects for e.g., coordinated validation, transport systems integration and large-scale piloting. Collaboration should also be sought with projects funded under HORIZON-CL5-2024-D6-01-01[56] and other directly relevant call topics.

In view of the relevance of environment perception and decision-making of automated vehicles for the responsiveness of the innovation to diverse societal interests and concerns, accessibility, and inclusiveness as well as regulation, proposals may consider societal, ethical, socio-economical and/ or legal aspects as far as feasible in the requirements of the technical solutions to be developed. This could involve the engagement of institutional users as well as citizen-science approaches, e.g., in collaboration with projects funded under CCAM Cluster 6.

International collaboration is highly relevant, considering the lessons learned (for example, from robo-taxi trials outside of the EU), while connecting the European ecosystem with relevant stakeholders around the world while considering specific European legal, cultural, historical, and social aspects as well as other specificities of the European road network and cities (e.g., traffic rules, user behaviour, streets morphology).

As such. 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-CL5-2025-D6-04: Integration of human driving behaviour in the validation of CCAM systems (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	

[56] Centralised, reliable, cyber-secure & upgradable in-vehicle electronic control architectures for CCAM connected to the cloud-edge continuum.

Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. Validated human behavioural models representing the variety of human driving behaviour in safety-relevant scenarios, shared through a common repository and to be used:

    a. to define societal responsiveness / assessment criteria for CCAM systems in type approval schemes, consumer testing campaigns and industrial development processes,

    b. to design safe, human-like behaviour of CCAM systems that can be anticipated easily by other road users and is acceptable to both occupants and other road users.

2. Application of such human behavioural models in the virtual safety validation of CCAM systems to realistically represent the behaviour of human-driven vehicles in closed loop simulations of mixed traffic, thereby reflecting the variety of human driving behaviour.

Scope: The deployment of CCAM systems in mixed traffic will mean intense interaction with other road users such as the human drivers of other vehicles as well as pedestrians and riders of two-wheelers. These interactions will play a crucial role in the societal responsiveness and thereby the penetration of CCAM systems in future road transport. CCAM systems will have to show safe and human-like driving behaviour, so that their decisions and actions can be anticipated easily by other road users, respecting the variety of typical driving behaviour across different countries as well as the need for CCAM systems to respect traffic rules and support road safety.

This will require validated models of explicit and implicit human driving behaviour in order to design and validate such system behaviour. In particular, these models will be needed in closed loop simulations of CCAM systems in mixed traffic to realistically represent the reactions of human drivers in other vehicles to the behaviour of a CCAM system. Models representing human driving behaviour shall be developed by the projects i4Driving and BERTHA under HORIZON-CL5-2022-D6-01-03 for selected fields of application, i.e. they will be calibrated for a limited number of scenarios. Bringing together and building upon the results of these projects – in particular a simulation library and an innovative methodology to account for uncertainty from i4Driving and a scalable, probabilistic driver behavioural model from BERTHA, research is needed to extend the fields of application that these projects are addressing with a focus on representing driver behaviour in a multitude of safety-critical scenarios, considering the variation and statistical distribution of human behavioural patterns and the factors influencing such behaviour, including the parallel execution of non-driving

related tasks. In order to achieve high degrees of robustness and applicability in a wide range of scenarios, detailed calibration and parameterisation is necessary, as driver behaviour depends on factors such as the road infrastructure, vehicle types, traffic conditions and rules, as well as regional influences. Considering the deviation of average from ideal human driving behaviour, proposed actions must also validate the models for their extended fields of application, going well beyond the applications and degrees of validation accomplished by the above-mentioned projects under HORIZON-CL5-2022-D6-01-03. Proposed actions shall thus raise the technology readiness of these models from TRL 4 to TRL 5. Data for parameterisation and validation should be captured by monitoring real human drivers in driving simulators and/or real traffic considering what is happening inside and outside the vehicle.

Proposed actions shall integrate the validated models in the virtual validation and verification approaches as developed in the projects HEADSTART and SUNRISE and complemented by the action(s) funded under HORIZON-CL5-2023-D6-01-02. Successful integration needs to be demonstrated in various safety-relevant scenarios as provided by the action(s) funded under HORIZON-CL5-2023-D6-01-02. Models should be shared via the federated data exchange platform for CCAM to be developed by a Cluster 7 project under the same call.

Proposals are encouraged to also explore additional fields of application of validated driver behaviour models.

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, 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-CL5-2025-D6-05: Approaches, verification and training for Edge-AI building blocks for CCAM Systems (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	

Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. CCAM solutions with reduced power consumption, latency, and improved speed and accuracy, as domain specific adaptions of sector agnostic advancements in e.g. AI and/or cloud-edge-IoT technologies.

2. Enhanced levels of safety, (cyber) security, privacy and ethical standards of data-driven CCAM functionalities by using e.g. edge-AI applications for CCAM.

3. Approaches for well-balanced distributions of AI calculations for expanding use cases (e.g. collective perception, decision making and actuation) for connected, cooperative and automated driving applications (using a balanced mix of edge-based solutions[57], cloud-enabled solutions and vehicle-central solutions), balancing speed and latency, energy use, costs, data sharing and storage needs and availability.

4. Validated approaches for the chain from perception and decision-making up to actuation of advanced CCAM functionalities -both on-board and on the infrastructure side- as well as for systemic applications such as traffic management and remote control. Tools and approaches for training of such functionalities, which are requiring optimised and verified edge-AI models.

Scope: CCAM enabled vehicles are constantly sensing their surroundings on road conditions, location, nearby vehicles and infrastructure. Such data is real-time being shared and data from other sources is received, requiring powerful and optimized large data processing algorithms. This altogether requires large amounts of computing power, data processing, real-time operation and high levels of security. However, most existing AI computing tasks for automated vehicle applications are relying on general-purpose hardware, which does have limitations in terms of power consumption, speed, accuracy, scalability, memory footprint, size and cost. Hardware advancements offered by activities related to e.g. the Chips JU calls need to be accompanied by major work to enable CCAM functionalities to run with optimised AI algorithms feasible for use on edge-specific hardware. To encompass CCAM solutions in

[57] Edge computing and edge intelligence (e.g., cognitive cyber-physical systems (CPS), intelligent embedded systems, autonomous CPS) are approaches where raw data is transformed into information as early as possible and close to the application, allowing also real-time triggering of actions. It helps to reduce throughput and communication costs, and to ensure privacy, efficiency, and safety requirements.

future steps towards e.g. the Software Defined Vehicle, this dual approach on AI advancements and hardware advancements is essential. Complementarities with projects funded under Cluster 4 “Digital Industry and Space” of Horizon Europe should also be considered where appropriate, especially in making the translation from sector-agnostic innovations to the specificities of the application domain of CCAM. This should consider specificities such as requirements on latency, on-board energy availability, ECU capacity and on safety-critical scenarios, to ensure timely triggering of actions.

Edge-AI involves deploying AI algorithms on edge computing devices, which are hardware systems constrained in proximity to the data source where they operate. This is done without relying on remote resources for the computational efforts. It thus facilitates real-time insights, responses and triggering of actions, with reduced costs as processing power close to the application is used, greatly reducing networking costs. Combining AI with such edge-AI can facilitate stable solutions to include the full chain from sensing, perception, decision-making up to actuation of advanced CCAM solutions, gaining e.g. speed which is essential in safety-critical situations.

To successfully overcome these challenges, proposed actions are expected to address all of the following aspects:

- For next major advancements in AI applications in CCAM solutions, it is needed to make huge AI applications fit to limited hardware, to make it fit for purpose. Edge-AI devices often have limited computational resources, making it challenging to deploy large and complex AI models. Thus it is essential to develop and reshape approaches and building blocks for CCAM solutions, viable to be run on edge-hardware. Use cases for the approaches and building blocks should focus on time-critical applications (such as in the chain from (collective) perception, decision making and actuation of functionalities) and can be linked to the activities and results from projects funded under HORIZON-CL5-2022-D6-01-04.

- Develop optimised edge-AI algorithms and demonstrate their applicability and scalability, using real-world CCAM scenarios such as in the databases resulting from projects funded under HORIZON-CL5-2023-D6-01-02. The development and demonstration use case should include in-vehicle perception and understanding, such as object detection, segmentation, road surface tracking, sign and signal recognition, etc. Decision making and actuation of countermeasures is to be part of the chain of actions. The approaches for these building blocks and enabling technologies should facilitate a quick uptake in adjacent or following projects.

- Optimisation of the models for edge deployment. This involves adjusting the size and complexity of models to allow it to run on the relevant edge devices and include training and verification approaches. Techniques such as model quantization, pruning, and knowledge distillation can be used to reduce the size of AI models without significant loss in performance. Additionally, over-the-air (OTA) updates can be used to manage and update models across a fleet of devices efficiently.

- Develop tools and approaches for edge-AI model monitoring, to ensure that edge-AI systems continue to operate as expected and ensure resilience to failure conditions or attacks, and monitoring model outputs to ensure they are accurate even as real-life conditions and datasets change (aligned with the AI act).

The research will require due consideration of cyber security and both personal and nonpersonal data protection issues, including the GDPR.

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-CL5-2025-D6-06: Federated CCAM data exchange platform (CCAM Partnership)

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Research and Innovation Action
Eligibility conditions	
Technology Readiness Level	
Legal and financial set-up of the Grant Agreements	

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

1. Overview of CCAM-specific limitations of current data exchange solutions and existing dataspaces related to interfaces, harmonised ontologies and taxonomies, standards, formats, monetization / compensation.

2. Mapping of information and reference data needs for KPIs collected by Member States related to impacts of CCAM technologies and solutions.

3. Federated sustainable CCAM Data Exchange Platform that facilitates sharing of data for both Large Scale Demonstrations and deployment, interfacing existing data spaces and improving the exchange, availability, and accessibility of data for the development, testing and deployment of CCAM services (including but not limited to Digital Twin, digital scenario representations, safety assurance and validation ADS regulation monitoring, AI

model training, and the collection of national/EU level statistics and Key Performance Indicators).

4. Proposed governance structure for the Data Exchange Platform with sustainability plan and viable business model.

Scope: Data sharing plays a pivotal role in supporting R&I, enabling deployment, and enhancing the competitiveness of the CCAM industry. Within the realm of data sharing, there are two distinct types of data that are particularly pertinent: mobility macroscopic solution and service providers, and the automotive sector for research and beyond. Firstly, in the domain of mobility macroscopic solution and service providers, the concept of a Mobility Data Space has emerged as a crucial need, with ongoing projects funded under the DIGITAL Europe program, supporting the deployment of the common European mobility data space and the setup of cross-sectoral data space components. This framework facilitates the sharing of data pertaining to mobility patterns, traffic flow, and other macroscopic aspects essential for the development of CCAM solutions. On the other hand, within the research, testing and deployment of CCAM solutions for automotive as well as infrastructure sectors, there is a need for a dedicated Data Space tailored specifically to the CCAM stakeholder's requirements. Unlike the Mobility Data Space, which primarily focuses on macroscopic data, this CCAM Data Space demands a more granular and extensive array of data to cater to the needs of both Tier X suppliers, Original Equipment Manufacturers (OEMs) and infrastructure providers, particularly in terms of safety considerations. Specific aspects related to ongoing regulations developments would need to be considered (e.g. ADS and GS regulations, adaption of type approval to AI Act including trustworthy AI integration…)

Several data spaces exist or are being developed in Europe for CCAM in ongoing R&I initiatives. The FAME Project has released a CCAM Data Sharing Framework (DSF) 2.0 describing best practices in data sharing and will develop a CCAM Federated Data Space as a proof of concept to facilitate the exchange of research and test data across R&I projects. Several CCAM Partnership R&I projects expressed interest in making data available and reusing data from other projects through the FAME Data Space, once it will operational. The scenario-based validation approach for safety argumentation in highly automated functions will result in an integration of various scenario databases facilitated by a federated layer, as developed in project SUNRISE and in projects funded under topic HORIZON-CL5-2023-D6-01-02. However, this integration falls short of constituting a comprehensive Data Space approach, both for new data sets and extensions of existing datasets. To achieve true Data Space functionality for CCAM, significant enhancements are required in terms of developing connectors, APIs, and protocols for seamless data exchange, Additionally, there is a need to refine user profile management systems and establish robust contractual frameworks to govern data access and usage rights.

Consequently, substantial efforts are necessary to fully integrate these approaches into a cohesive and efficient Data Space environment that can effectively support the diverse needs of the CCAM research community and industry. Moreover, extensive datasets are also indispensable for the development of low-level modules such as driver monitoring systems,

perception systems, and decision-making algorithms, as well as for sensors like GNSS, radar, cameras, and lidar. While projects like AITHENA and AWARE2ALL have generated valuable datasets, the lack of centralized storage and access hampers their utility. Therefore, there is a strong need to incorporate such datasets into a unified Data Space framework. By establishing robust interfaces, ontologies, and data management architectures, the CCAM research community and industry can effectively utilize and repurpose existing data, thereby reducing costs, and facilitating the development and validation of CCAM solutions, including the creation of digital twins through synthetic data. The enhanced sharing of data across the CCAM stakeholders should also benefit national authorities, and operators in their efforts to collect KPIs to monitor wider impacts of CCAM solutions including on safety, economy, and society.

Proposed actions for this topic are expected to address all of the following aspects:

- Identify how to further evolve the data spaces for CCAM applications, connecting existing dataspaces and bridging data gaps.
- Identify harmonization and standardization needs for taxonomies, interfaces, and data formats to push CCAM data exchange and extend and Implement the CCAM taxonomies in the CCAM Test Data Space.
- Identify information needs and reference data for KPIs collected from Member States (high level socio-economic statistics, accidents, infrastructure, vehicles).
- Establish a Federated CCAM Data Exchange Platform with tools and governance, including a viable business model to ensure the sustainability of the platform, which facilitates sharing of data for industry, authorities and academia that are supporting: Large Scale Demonstrations, the generation and maintenance of the digital twin and representation of scenarios (for development or validation), performance and safety assessment, ADS regulation monitoring, AI model training, and common information source for national/EU level statistics and Key Performance Indicators.
- Identify the effects of the EU General Data Protection Legislation (GDPR) into AI learning workflows and possible mitigation measures.

A strong link with the common European mobility data space and related cross-sectoral initiatives (DIGITAL EUROPE) is required. The work should build on the outcomes of the FAME project and the FAME Test Data Space (Data Sharing - Connected Automated Driving). Finally, links with related initiatives from the European Digital Infrastructure Consortium (EDIC) and a cooperation with the CCAM Partnership Member States Representative Group (SRG) are required.

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

HORIZON-CL5-2025-D6-07: Innovative construction and maintenance, with the use of new materials and techniques, for resilient and sustainable transport infrastructure

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	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

Demonstration of combined solutions for infrastructure construction that achieve the following targets:

- At least 50% of the construction materials used are recycled or sourced from recycled materials;
- Reduced pollutant emissions by at least 30% considering the entire life-cycle of the infrastructure;

- Reduced degradation of ecosystems and fragmentation of habitats during construction, maintenance, operation and decommissioning of transport infrastructure.

- Increased climate resilience of infrastructure to extreme weather and human caused events, assuring at least 80% capacity at network level during the disruptions.

- Structured analysis and recommendations for a need for EU standards in construction, inspection, maintenance and deconstruction contributing to decarbonisation and increasing resilience of transport infrastructure,

Guiding document on the necessary adaptations to public procurement rules that contribute to include clear sustainability and resilience award criteria.

Scope: The overarching policy background is the European Grean Deal, focused on how to achieve climate neutrality by 2050. In the transport area, this translates into 90% reduction of emissions by 2050. To deliver the European Green Deal, a need to rethink numerous policies will including those for transport and large-scale infrastructures.

The EU Sustainable and Smart Mobility Strategy (SSMS), which translates this general target into actions, states that infrastructure must be adapted to climate change and made resilient to disasters. In line with SSMS, it is also important that the infrastructure put in place relies on clean and decarbonised energy sources, notably renewable energy, as well as on a modernised grid to ensure achieving the decarbonisation of the transport sector in line with the European Green Deal.

Research in this topic should provide knowledge and technical solutions to a triple challenge: limiting emissions of transport infrastructures; making them more resilient to climate change; and addressing environmental and biodiversity aspects. Projects should cover the entire life cycle of transport infrastructures, covering overall emissions from sourcing of materials , construction, maintenance, operation and decommissioning of the infrastructure.

Proposals should address all of the following aspects:

- Development of new methods and techniques to construct, manage, maintain and (self) repair transport infrastructures, in order to increase climate resilience and lower emissions.

- Assessment of solutions considering the principles of circularity and taking into account the entire life-cycle assessment (LCA) approach.

- Cost-benefit analysis (CBA) of the solutions considering the entire life-cycle of the infrastructure and accompanying business plans for their implementation.

- Application of innovative materials (e.g. green asphalt and green cement) that contribute for transport infrastructures that are more resilient and emit less pollutants

- Validation of all the proposed solutions and proofs of concepts is to be carried out in at least two large-scale demonstrations. The demonstrations should cover at least 2

different transport infrastructure types (e.g., road, rail, waterborne, airport) which are located on at least 2 different Trans European Transport Network (TEN-T) corridors. The demonstrations should also cover different environments and phases of the infrastructure life cycle (e.g., design, construction, maintenance, decommissioning).

- Analysis of EU national and international standards in construction, inspection, maintenance and deconstruction, contributing to decarbonisation and increasing resilience of transport infrastructure.

- Design of green, sustainable, and innovative public procurement methods, contributing to lowering the environmental footprint, resources, and material consumption.

- Demonstration of sustainable and climate resilient infrastructure with nature-based solutions (NBS), minimising the negative effects on the environment, including on the degradation of ecosystems, the fragmentation of habitats and the loss of biodiversity.

The expected outcomes should be supported by clear indicators with baselines and quantified targets which are monitored for each demonstration site. The expected outcomes should take into account expected technological developments and policy implementation (eg revised TEN-T regulation).

Proposals should consider and build on results from previous calls on resilient and sustainable infrastructure and standards[58] and should uptake relevant EU guidance on development and management of European transport infrastructures. Proposals should also build on previous results from projects on advanced materials, sensoring, digitalisation, asset management, decision support and automation in the construction and maintenance of infrastructures. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, the proposal is expected to describe how the use of Copernicus and/or Galileo/EGNOS are incorporated in the proposed solutions. If the proposed activities and solutions involve the use of artificial intelligence (AI) systems and/or techniques, the proposal is expected to demonstrate that robustness of the solution.

HORIZON-CL5-2025-D6-08: Accelerating freight transport and logistics digital innovation

Specific conditions	
Expected EU contribution per project	

[58] https://im-safe-project.eu/

Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected outcome:

The proposals are expected to contribute to all the following outcomes:

- Extended functionalities of certified electronic Freight Transport Information (eFTI) platforms established in conformity with Regulation 2020/1056[59] for:
    - new applications and services facilitating harmonised electronic business-to-business (B2B) information sharing, such as those related to GHG reporting, sustainability claims and other actions leveraging efficient and green freight operations in the supply chain;
    - complementary applications and services for electronic business-to-authority (B2A) information sharing aimed to support the implementation of relevant Union regulatory frameworks in transport, such as in the context of statistics, sustainability reporting, GHG and external costs calculators;
- Improved digital connectivity and interoperability of the information shared electronically between actors in both B2B and B2A perspective;
- Reduced administrative burden and costs associated with B2B data sharing and B2A regulatory and non-regulatory reporting;
- Increased efficiency of freight transport and hub operations thanks to the use of electronic means, streamlining the data sharing processes and accounting for interoperability.

Scope:

[59] Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information; https://eur-lex.europa.eu/eli/reg/2020/1056/oj.

eFTI platforms established in line with Regulation 2020/1056 will play a central role in facilitating the implementation of business-to-authority (B2A) information exchange processes related to transport of goods. In line with the Regulation's requirements, common specifications for a single comprehensive data set and harmonised protocols for data sharing will ensure interoperability of the information shared electronically between actors, and the requirements for rights-based access-control system will establish safeguards for cybersecurity and trust.

The use of electronic means to exchange regulatory information will reduce administrative costs for economic operators and can enhance the efficiency of freight transport services. Therefore, given their potential, apart from specific B2A functionalities, eFTI platforms could also serve as an enabler for other universal, open and affordable solutions and tools to achieve digital interconnectivity of logistics systems including in B2B perspective, with minimal integration effort and considering SMEs needs and capabilities.

The proposals should unlock the potential of eFTI platforms for further functionalities, beyond the scope of Regulation 2020/1056, to new B2B services and applications as well as other B2A uses.

Proposals will have to refer, as a core principle, to legislative framework and specific technological solutions provided through Regulation 2020/1056, while duly reflecting the latest technological state of the art for electronic information exchange. Where relevant, and especially in B2B perspective, they will have to apply and build upon the concepts and solutions developed in other Union initiatives aimed to facilitate data sharing in transport, the Digital Transport and Logistics Forum (DTLF) and the European mobility data space (EMDS).

Proposals must not propose any type of architecture, federation of platforms or similar, as these are already delivered by eFTI and DTLF, while they are expected to leverage existing frameworks or platforms to ensure effective use case implementation.

The proposals should address all of the following aspects:

- Building on the requirements and implementation specifications for eFTI platforms provided for in the eFTI Regulation and its implementing and delegated acts, develop relevant technical solutions at least at the level of operational prototype demonstration (TRL7);
- Identify and define relevant data to be added to the existing eFTI common dataset to support the new services and functionalities;
- Address aspects of data sovereignty, data privacy and cybersecurity, pursuant to the relevant Union legislation;
- Provide recommendations for specific B2B framework arrangements (such as standard data exchange contracts and identification/authentication requirements) to ensure trusted operation of proposed prototypes;

- Seek compliance with other complementary EU frameworks (such as new Commission's proposals for the amendment of the Combined Transport Directive[60] and the Regulation on CountEmissions EU[61], and the Corporate Sustainability Reporting Directive[62]), to facilitate their effective and harmonised implementation, including through the establishment of an open source GHG and external cost calculators, as well as the exploitation of data sharing frameworks for carbon reporting between operators in the same supply chain;

- Validate the proposed solutions in at least 2 demonstration pilots. B2B use cases have to be led by industry stakeholders, in particular shippers and logistics service providers (e.g. freight forwarders, transportation companies). B2A use cases have to be developed in cooperation with industry stakeholders, researches and public administrations, including statistical offices.

HORIZON-CL5-2025-D6-09: Establishing reliable data and effective practices to support measurement and accounting of emissions and other external costs in multimodal transport chains

Specific conditions	
Expected EU contribution	
Indicative budget	
Type of Action	Coordination and Support Action
Eligibility conditions	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

[60] https://transport.ec.europa.eu/document/download/9024df1d-7fd9-439d-aa57-478f336f8dc8_en?filename=COM_2023_702_1.pdf_2023_702_1.pdf

[61] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the accounting of greenhouse gas emissions of transport services (Text with EEA relevance); https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52023PC0441

[62] Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting (Text with EEA relevance); https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

	additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected outcome:

The proposals are expected to contribute to all the following outcomes:

- Input is provided for the implementation of the existing and forthcoming Union's regulatory initiatives related to measurement, calculation and reporting of emissions in transport, such as Regulation (EU) 2023/1805 (FuelEU Maritime)[63], Regulation (EU) 2023/2405 (ReFuelEU Aviation)[64], and the recent Commission's proposal for the Regulation on the accounting of greenhouse gas emissions of transport services (CountEmissions EU)[65];

- Methodological components are developed and proposed to complement the methodology provided through CEN ISO standard 14083 as per specification set out in section "Scope" below;

- Methods and techniques for measuring and collecting emissions data as per specification set out in section "Scope" below are developed and proposed.

Scope:

Greenhouse gas (GHG) emissions from transport represent around 25% of total man-made GHG emissions and continue to grow. The negative impact of these is further strengthened by the existence of other external costs of transport, including air pollution, noise, congestion and accidents. Hence, the EU, Member States and industry have made considerable efforts to address this situation and to reverse the negative trend.

Accurate and reliable information on emissions is an important tool to increase effectiveness of specific reduction emissions measures undertaken by public authorities and businesses. Over the past 15 years lot of progress has been made at EU level and globally through new regulatory actions and continuing collaboration between actors to improve the transparency of transport GHG emissions and external costs monitoring. This is manifested through:

[63] Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC

[64] Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport

[65] COM(2023) 441 final

- Regulatory initiatives including Regulation (EU) 2023/1805 (FuelEU Maritime)[66], Regulation (EU) 2023/2405 (ReFuelEU Aviation)[67], Regulation (EU) 2015/757 (EU MRV)[68] and especially, the recent Commission's proposal for the Regulation on the accounting of greenhouse gas emissions of transport services (CountEmissions EU)[69];
- Relevant EU research projects, including "Carbon Footprint of Freight Transport" (COFRET), "Logistics Emissions Accounting & Reduction Network" (LEARN) and a new action to start shortly on creating legitimate emission factors for verified GHG emission reductions in transport;
- Standardisation work, including ISO 14083, the official international standard developed between November 2019 and October 2022 and published in March 2023 as part of the 14000 family of ISO GHG-related standards[70];
- Regular updates of the Handbook on the External Costs of Transport[71];
- Industry initiatives, such as the Global Logistics Emissions Council (GLEC) Framework, the industry-led guideline for GHG calculation and reporting in the global logistics sector.

In spite of these big steps forwards further work is required to ensure that:

- The full climate impact of transport operations is covered in a comprehensive and consistent way;
- Any open items identified in the first edition of ISO 14083 as a reference method for CountEmissions EU can be closed;
- Any detailed tweaks to the methodology that have come to light through application can be developed and tested in view of the implementation of CountEmissions EU and the planned revision of ISO 14083 standard;
- New technologies and business models are reflected in datasets and methodologies;
- Relevant data is available for the proper implementation of other EU climate related legislation in transport, including Regulations on Fuel EU Maritime, ReFuelEU

[66] Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC
[67] Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport
[68] Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC
[69] COM(2023) 441 final
[70] This standard has also been formally adopted by the European Committee for Standardisation (CEN) under the reference CEN ISO 14083
[71] https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

Aviation, EU MRV and Council Directive 92/106/EEC (Combined Transport Directive)[72].

- Standardized systems and integrated solutions are available to facilitate collection, measurement, monitoring and accounting emissions for business and regulatory purposes.

The Action will therefore play a central role in supporting implementation and further development of Union's frameworks aimed to tackle emissions in transport. However, the Action should also facilitate alignment between EU policy development and market implementation, especially towards enabling market-based accounting approaches that would support proactive investment in low emission fuels and associated transport services.

The Action should aim to ensure high quality and accuracy of collecting data for measuring, calculation and monitoring of emissions and other external costs from transport and logistics activities.

The proposals should address all of the following aspects:

- Building on results of a new action to start shortly on creating legitimate emission factors for verified GHG emission reductions in transport, update the list of applicable GHG emission factors for emissions stemming from energy production, distribution and use; and develop emission factors for categories not yet covered;
- Explore, assess and establish the state of the art regarding issues of measuring certain emissions, in particular:
    - black carbon emissions, which primarily result from the combustion of fossil fuels in compression ignition engines;
    - radiative forcing, which has been suggested as having a strong supplementary climate impact at high altitude and is already included in an inconsistent manner across some, but not all, transport GHG reporting programs,
    - GHG emissions from vehicle manufacturing and scrappage which, although not directly linked to transport operations, do contribute to overall lifecycle transport emissions,
    - GHG emissions that result from the installation of transport infrastructure, which would need to include definition of rules for the combination of operational and lifecycle emission calculations into a meaningful and consistent presentation format,

[72] Council Directive 92/106/EEC of 7 December 1992 on the establishment of common rules for certain types of combined transport of goods between Member States

  - GHG emissions associated with the maintenance operations associated with transport operations which are currently excluded,
  - development of a detailed methodology for GHG emissions stemming from temperature-controlled transport & cool chain operations,
  - allocation of GHG air transport emissions across passengers and freight transported on the same aircraft,
  - GHG emissions from ICT equipment and data servers that support the delivery of transport operations.

- Based on relevant European/national/sectorial repositories, explore, assess and contribute to an EU core dataset of default values for GHG emissions intensity of transport services, including for supporting relevant EU regulatory initiatives (such as the upcoming regulation on CountEmissions EU and revised Combined Transport Directive);
- Building on existing sources (in particular the updated Handbook on the External Costs of Transport), develop a common dataset of granulated default unit values for external costs of transport, including GHG emissions, climate change, air pollution and noise which reflect performance of different energy systems and propulsion technologies;
- Develop standardised systems that integrate collection, monitoring, measurement and calculation of emissions, including through the development of innovative decision making support applications, remote sensing and AI solutions. These systems should also support automatic calculation and standardised reporting of emission outputs required under different EU and international regulations, and should ensure highest standards with respect to data handling security, reliability, storage and cyber-safety compliance;
- Develop an integrated modelling approach to complement primary data collection in line with current modelling techniques, to reply to current and future regulatory requirements.
- Develop ideas and solutions for a more extensive re-use of the data collected to lower administrative burden to meet regulatory or reporting requirements.
- Support collaboration among public and private actors to improve the transparency of transport GHG emissions and external costs monitoring.

HORIZON-CL5-2025-D6-10: Integrating inland waterway transport in smart shipping and multimodal logistics chains

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Actions
Eligibility conditions	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).
Technology Readiness Level	Activities are expected to achieve TRL 7-8 by the end of the project – see General Annex B.

Expected outcome:

- Better integration of inland waterway transport (IWT) into the overall logistic chains as required by NAIADES III, supporting in increase the modal share of inland waterway transport, as well the awareness relating to the advantages of IWT as an alternative mode of transport;
- Clear definitions of Smart Shipping (smart vessels, smart infrastructure, smart data, smart regulation) and Smart Logistics, including implementation and operation guidelines for Smart Shipping in inland waterways cargo and passenger transport;
- Increased automation, digitalisation, standardisation and interoperability of processes, technologies and equipment, particularly between IWT vessel and infrastructure and cargo transport/transhipment procedures in multimodal freight transport nodes;
- Regular, commercially viable and regulatory compliant operations of smart and automated vessels in cross-border transport;
- Recommendations for a regulatory model framework operation of smart and automated vessels in particular for cross-border operations, their connections with the hinterland and the logistic chains and input to the standardisation and harmonisation of

the smart shipping components to the relevant standardisation bodies (e.g. CESNI, CEN CENELEC).

Scope:

Despite obvious environmental advantages the modal share of the EU inland waterway transport (IWT) sector has remained behind expectations in the last decades. The seamless integration of inland waterway transport in multimodal supply chains requires the physical and digital connection to other transport modes. Digitalisation is not a goal in itself but an important supporting development required to remain competitive and to improve the connectivity to ports, other transport modes and the clients (e.g. to keep the direct costs low and to allow synchromodal solutions). Digital interconnectivity is crucial to increase the modal share of IWT in multimodal logistics chains and to be able to significantly contribute to the modal shift goals as presented in the Sustainable and Smart Mobility Strategy[73].

The proposals should address all of the following aspects:

- Building on previous and on-going Horizon 2020, Horizon Europe and CEF funded projects, identify and develop technical and operational solutions to connect physically and digitally IWT to existing multimodal logistics chains for a safe, sustainable, resilient, automated, efficient and green IWT with a view to synchromodal transport.

- Validate the proposed solutions for advanced cooperative Smart Shipping and Smart Logistics in at least 2 demonstration pilots in actual operational environment (minimum at TRL 7). The demonstration should focus on better integrating inland waterway transport in overall supply chains and on the accessibility and usability of node services in an automated/digital manner as well as on efficient and green operations. To ensure a user perspective approach, the pilot cases have to be led by industry stakeholders, in cooperation with public administrations as necessary.

- Develop and demonstrate operations including cross-border operations of automated vessels and their interaction with the physical infrastructure.

- Identify gaps for achieving harmonised smart transport across borders and make recommendations on regulatory requirements and measures.

- Define and develop key parts of the IWT related aspects of a common framework for multi-modal data sharing while enabling compatibility with legacy systems; building upon the concepts and solutions developed in other Union initiatives aimed to facilitate data sharing in transport, the Digital Transport and Logistics Forum (DTLF), the European mobility data space (EMDS); and considering high value datasets, the revised ITS Directive[74] and River Information Services (RIS) Directive. Proposals

[73] Sustainable and Smart Mobility Strategy – putting European transport on track for the future, COM/2020/789 final
[74] Directive (EU) 2023/2661

must not propose any type of new platforms or similar, but are expected to leverage existing frameworks or platforms to ensure effective use case implementation.

- Develop education and training programmes for new skills required by Smart Shipping.
- Demonstrate and quantify the benefits of Smart Shipping (especially automated vessels) and Smart Logistics to support multimodal logistics operations.
- Implement communication activities displaying the specific advantages of integrating IWT in the logistic chain, in line with the objectives of the Sustainable and Smart Mobility Strategy.

Safety and resilience

HORIZON-CL5-2025-D6-11: Safe Human-Technology Interaction in the Coming Decade

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility conditions	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).
Type of Action	Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

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

- Increased understanding of the synergies between driver and driving assistance systems capabilities and implementation of tailored, "self-learning" HTI strategies in order to improve road safety;

- Avoidance of crashes related to mode confusion during the use of driver's assist, the hand-over and take-over phase;
- Advanced standardisable assessment tools and methods for improved HTI;
- Development of training methods for new drivers with respect to the evolving technologies.

Scope:

The increasing automation of road transport is bringing up new challenges especially in lower automation levels (level 4 and below) when driving control is transitioning from the driver to the vehicle or vice versa. For these levels, ensuring the right level of driver vigilance with respect to the context and the automation level is important to avoid dangerous situations because of cognitive distraction.

In addition, systems based on HTI are generally built on a non-stationary and non-deterministic foundation – human behaviour. Therefore, the concept of individually "adaptive" systems has to be followed and elaborated in all its particular aspects, as the consideration of "average" human behaviour is not sufficient.

This has large implications on the design of HTI systems.

Such systems should provide a reliable and seamless interface between the driver and the vehicle in normal driving conditions as well as in specific situations with a risk of generating high cognitive load, diverted attention, inattention, impaired driving or in the case of instantaneous limitations in driving capabilities.

As drivers and their experience, as well as driving conditions, may vary a lot, HTI systems will need to address a wide variety of use cases in order to ensure a relevant ODD (operational design domain). Therefore, in-cabin monitoring systems with adequate accuracy are key to have a clear understanding of the driver state, while considering all contextual in/out cabin data, so that the vehicle can propose a pertinent and tailored strategy to prompt the required driver action or behaviour.

Advances in cabin monitoring and multi-modal sensing technologies as well as robust detection/prediction of driver cognitive status adapted to the situation awareness will be necessary to achieve these objectives. The same applies to the need of linking interior with exterior sensing capabilities.

In addition, it is necessary to enhance driver's understanding of the assisted and automated driving system and avoid mode confusion. In this aspect, the implications of automation on driver training and driver's licence requirement should be investigated. This could include innovative training methods that prepare drivers for various mode transitions and safety critical scenarios like the development of virtual and mixed reality training approaches. The automation status and the limits of the system should be clearly communicated via the HTI to

prevent mode confusion, enhance trust and avoid unnecessary deactivation of the assistance or automation systems.

Special attention should be dedicated to the "hand-over" and "take-over" phases. Hand-over/take-over requests should be done considering the context (e.g. information from other vehicles or infrastructure) and the state of the driver in a way to minimize cognitive stress related to hand-over and take-over. In this context, it is important to investigate standardized requirements for the human-machine interface (incl. in case of system failure) including their assessment.

In this respect, research should address the development of relevant strategies to avoid driver disengagement and reduce cognitive load in critical situations, as well as behavioural models and methodologies to identify activities/behaviours that should be avoided or blocked by the vehicle HTI (e.g. availability of systems, such as entertainment systems, that are most likely to distract the driver from the driving tasks). These strategies should be scalable to the available vehicle sensing sophistication.

Some specific use cases, such as elderly drivers with declining sensing and higher sensibility to cognitive load, young and inexperienced drivers and professional drivers performing other tasks simultaneously will also need to be addressed. For these populations a key research question will be how to meet their specific needs and how to realise the best compromise between tailored vs. standardised approaches.

Also, trust is mandatory for the acceptability of these systems: precision, reliability, and transparency need to be ensured. In particular, the vehicle response to a given situation as well as the level of information to be conveyed needs to be coherent and logical. Relevant research areas to achieve this objective will be the definition of multi-modal and multi-sensorial vehicle warning and response strategies for the safe management of critical phases considering user responsivness and the severity of scenarios.

HTI systems should be upgradable both in software and in hardware with minimal disruption for the users, while ensuring that the intended effect and functionality is improved or at least maintained. A cross-fertilisation opportunity would be to investigate how other transport modes (e.g. aviation) handle upgrades/updates with minimal disruption for the user.

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, to produce meaningful and significant effects enhancing the societal impact of the related research activities, in particular in the context of identifying driver acceptability criteria and pain points as well as in setting up use cases.

Further research and data collection is needed to ensure a better understanding of the synergies between driver and assistance systems, to evaluate their performances in different contexts and user scenarios. This will enable to tailor appropriate adaptive and "self-learning" strategies to the individual driver abilities and preferences.

In consideration of the above, proposals should address all the aforementioned aspects and issues in order to achieve the expected outcomes.

These research needs should be addressed in coherence and continuation with the call topics HORIZON-CL5-2021-D6-01-10, DT-ART-03-2019, and HORIZON-CL5-2022-D6-01-02[75].

HORIZON-CL5-2025-D6-12: Safety of Cyclists, Pedestrians and Users of other Micro-mobility Devices

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility conditions	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).
Type of Action	Research Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

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

- Improved road safety (actual and perceived) for pedestrians, cyclists, and e-cyclists and users of other micro-mobility devices, considering that the safety of of these users is not only at risk with motorized vehicles but also from their interaction with road users with higher masses or operating speeds (e.g., between e-bikes and pedestrians).
- An advanced understanding of the specific safety needs of (e-)cyclists and users of other micro-mobility devices with guidance for design approaches for such devices, considering

[75] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl5-2021-d6-01-10
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl5-2022-d6-01-02

that these vehicles have varying sizes, serve different users ranging from commuters to delivery employees, and can be shared or owned.

- Increasing use of active and micromobility modes in all age and socioeconomic groups.
- Standarization guidelines for the authorities (police and hospitals) on how to report the vehicle type during crash reporting.
- Development of mitigating solutions for the adverse impact of the changing car fleet towards bigger and heavier vehicles to the safety of cyclists, pedestrians, and other users.
- Analysis of the impact of the infrastructure (e.g. design, markings, degradation status, quality, network connectivity) on the safety and comfort of its users and proposed mitigation solutions
- Assessment methodologies to evaluate the safety potential and the effectiveness of advanced safety measures.
- Pilot testing of all the developed solutions and methodologies on at least two real-world environments considering geographical diversity.

Scope:

In many regions, the share of trips made by active modes of transport is increasing, which is in line with the UN Sustainable Development Goals. At the same time, electrically assisted modes such as e-bikes and e-scooters, usually referred to as micromobility modes, have emerged and are continuously expanding as they represent an efficient means of personal mobility as well as a new mode for deliveries. This increasing demand for active travel and micromobility it is a development that needs to be supported by improving the safety of all types of active users since they are still disproportionally affected by crashes.

To decrease the number of road fatalities and serious injuries and improve the levels of safety and comfort of pedestrians, cyclists and micromobility users major actions are needed. Actions should focus both on the understanding of crash contributing factors while accounting for exposure, and on capturing the interactions between different factors. This will determine underlying mechanisms and baseline scenarios, leading to an increased understanding of the specific safety needs of these road users. Additionally, actions should also consider a range of social factors such as gender, age and cultural differences, trip purpose (e.g., recreational trip vs working trips). Actions should also take account of the safety level as perceived by pedestrians, cyclists and micromobility users.

The safety of both completely unprotected and partially protected road users riding these vehicles needs to be continuously and properly addressed. The increasing use of communication technologies can be an enabler, as can be improved human-technology interaction technologies and methodologies.

The detection of micro-mobility devices by motor vehicle-based sensor systems is making progress. Research should focus on V2X based detection of these types of road users, advancing on e.g. the MeBeSafe and the SAFE-UP projects. The inclusion of behavioural aspects is an aspect that needs further research, including the area of safety coaching features (nudging). This research should lead to dedicated measures for automatic conflict resolution and protective safety measures for crash mitigation and a forgiving infrastructure. It shall result in new and advanced safety measures both from a technological and a behavioural perspective, while limiting the costs. New assessment methodologies are needed to evaluate the safety potential as well as the effectiveness of these advanced safety measures. Both fatalities and injury severity reduction should be taken into account in such methodologies. An FOT approach is suggested here.

For the bicycles and micromobility devices the risks of both single-user crashes as well as multi-vehicle and multi-user crashes, e.g., with other micro-mobility devices or vehicles, should be assessed with the objective to capture the underlying crash mechanisms while accounting for exposure by assessing the crash risk. Crash risk addresses the probability of harm faced by users. This means assessing crash occurrences against some measure of people's exposure to those harms. In addition to crash frequency, risk reflects the probability of crashes and their severity. It is characterised as the road safety outcome for an amount of exposure, such as the overall number of trips or distance travelled. This concept recognises that safety is not solely determined by the number of incidents but is also influenced by how much individuals are exposed to potential risks. In fact, risk may diminish even with a rise in absolute crash numbers, emphasising the complex interplay between exposure and road safety outcomes. Therefore, proposals should provide a thorough risk assessment for each category of targeted users and provide concrete actions for reducing the respective risks.

Due to the recent emergence of e-bikes and e-scooters these crashes are increasing and are particularly affecting elderly individuals whose mobility options are expanded by these e-assisted devices. Special focus should be paid to supporting the safety of such user groups with particular vulnerability including people with disabilities. Targeted data collection, to look at safe riding, threats to stability and safety, and consequential falls or collisions is seen as a logical extension of an FOT and any pre-trial study. This, together with the aforementioned assessment methodologies, should be ready to be used in new designs of these and other micro-mobility devices, as well as in the underlying development of a draft European regulatory framework on e.g., riding requirements, and the potential for type-approval of micro-mobility devices or self-certification based on harmonized standards.

In consideration of the above, proposals should address all the aforementioned aspects and issues in order to achieve the expected outcomes.

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, to produce meaningful and significant effects enhancing the societal impact of the related research activities, with a focus on human-technology interaction, responsiveness of safety solutions and how this varies across different population groups, and behavioural aspects.

HORIZON-CL5-2025-D6-13: Predicting and avoiding crashes based on AI and big data

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Eligibility conditions	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).
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 5-6 by the end of the project – see General Annex B.

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

- Knowledge of high-risk locations along the road network becoming available, before crashes
  actually occur, enabling road authorities to deploy appropriate countermeasures pro-actively.
- Predictive identification of safety-critical situations based on data from multiple sources and enabling real-time interventions to avoid crashes.
- Determination of the optimal sample size to allow for reliable real-time crash occurrence prediction.
- Enhanced monitoring of traffic flows and incorporation of traffic flow variations and patterns in real-time crash prediction, which will also lead to more effective traffic management by foreseeing unexpected or disruptive events.

Scope:

One of the principles of the Safe System Approach is to turn from mainly re-active to pro-active management of road safety, i.e. not to derive needs for intervention primarily from

crash investigations, but to intervene before serious crashes happen. The ubiquitous gathering of ever-growing amounts of data and their processing in the digital transport system support this idea providing valuable information on traffic situations and events. Potential data sources include amongst others: smart phones, wearables, connected vehicles, drones, road-side cameras etc. Progress in computing power, in the accuracy of location services and in video analytics are further enablers in the processing and analysis of such data in order to identify safety-critical situations or conflicts based on surrogate safety metrics.

In terms of crash prediction modelling artificial intelligence has the potential to identify underlying risk complex relationships between large and diverse datasets which in turn will lead to the identification of crash contributing factors and their interrelations . The identification of these risk factors may then allow predicting safety-critical situations at quantifiable risk levels and guide the proactive implementation of crash mitigating measures , as proposed amongst others by the International Transport Forum at the OECD. Ideally, interventions would be feasible in real time and increase the safety of all road users.

Research should address all the following aspects:

- Development of an AI-enabled digital twin of traffic and infrastructure. This would integrate historical, current, and forecast data, including crowdsourcing and infrastructure sensors, infrastructure topology and condition, along with environmental (local weather and visibility) and traffic conditions. Such a digital twin can allow monitoring and preventively optimising both safety and traffic flow, equally addressing congestion and resilience issues.

- Analyse in detail the technical challenges associated with the acquisition and use of adequate and reliable big data from multiple sensors in the road transport system, as well as the process of combining these datasets in ways that are meaningful for proactive road safety analysis.

- Develop methods and tools to predict safety-critical traffic situations at quantifiable risk levels based on real time and historical data.

- Account for biases in the datasets and ensure that the developed AI-based models or algorithms are bias-free, so that the safety of all road users will be improved effectively in a fair, non-discriminatory way.

- Analyse in detail also the non-technical challenges associated with this approach and the inherent need to collect and share large amounts of data that can be used to identify and quantify road safety-related risk factors. Ethical, legal and economic issues should be considered and concepts be developed to overcome these challenges in terms of privacy concerns, questions of data ownership, organisational barriers etc.

- Analyse what real-time countermeasures can be taken to reduce instantaneous risk levels for all road users complementary to existing Intelligent Transport Systems (ITS) services.

- Demonstrate the feasibility of such risk predictions and targeted interventions.
- Build consensus among relevant stakeholders on possible routes for deployment in coordination with other ITS services.

Ways to leverage valuable complementary data, e.g. metadata from crash databases, should also be explored as well as links to initiatives for European data spaces.

Research is expected to develop recommendations for updates to relevant standards and legal frameworks. International cooperation is advised, in particular with projects or partners from the US, Japan, Canada, South Korea, Singapore and Australia. Knowledge and experience from other modes where similar approaches are followed in much more controlled environments should be leveraged.

HORIZON-CL5-2025-D6-14: Icing in the context of sustainable aviation

Specific conditions	
Expected EU contribution per project	
Indicative budget	
Type of Action	Innovation Action (TRL 5-6)

Expected outcome:

The climate evolution with increasing weather hazards, the new generation of low CO2 aircraft with associated disruptive configurations, the stringency of new policies and certification rules justify the need to initiate research in the field of icing, to ensure safety and efficiency of proposed new solutions (TRL 3-5).

In the mid-term the following benefits could be expected, to have:

- the scientific expertise to develop means of compliance for the certification of icing systems;
- the scientific knowledge to be able to develop new prototypes of ice detection and protection.

Scope:

The field of aircraft icing is of particular importance because it relates to the safety of flight facing adverse weather conditions, which became increasingly extreme during the last decade.

The aviation industry is working to develop the future clean and sustainable aviation. There is the need to innovate while maintaining safety.

To enable design, validation and future certification of new technologies emerging from clean aviation, future research should be initiated on the following three principal areas:

1. Research to prepare for the development of means of compliance for certification of future sustainable aviation concepts including:

- Development of reliable numerical tools to be used to validate the designs against the icing environment of Appendix C, O, P and snow.
- Development of Supercooled Large Drop Testing Capabilities such as icing wind tunnel test or ice tankers.
- Development of European Ice Crystal test Capability (For engine /air data probe).
- Development of Falling / Blowing Snow Testing Capability.

2. Research on Icing environment to assess the impact of the climate change effects on the certification icing environments and characterise the Icing environment applicable to new air mobility products flying at low altitude[76].

3. Research of new/technologies for Ice detection and protection, including:

- Ice crystal and SLDs Ice Detection systems to optimise Ice crystals protection or support the detect and exit the SLD appendix O or a portion of the appendix O conditions.
- High Efficiency/Low Energy protection: cleaner aviation with more electric airplanes will drive the need for new ice protection technology: more effective and with less energy.
- Dissimilar means for Air data (AOA/Speed) measurement and insensitive to icing threat. Air speed and aircraft attitude measurements are crucial for aircraft control. Air data/navigation probes are externally mounted and exposed to adverse conditions. Dissimilar means to determine the Aircraft speed and attitude would provide benefit and make the air data system even more robust / fault tolerant to environmental conditions (icing/hail).
- Enhanced aircraft performance / Ice protection health monitoring to improve the ice protection system monitoring coverage based on smart systems capable to monitor a large number of aircraft parameters.

[76] Note: the project will assess the use of specific models for the prediction of icing conditions (e.g., addressing cloud micro-physics for the formation ice crystals, super cooled water droplets), which can be coupled to climate models (e.g., General Circulation Models).

This research and innovation topic is linked to several ongoing rulemaking actions of the European Aviation Safety Agency:

- RES.0010 Ice Crystal Detection
- RES.0017 Icing hazard linked to super cooled large droplets (SLD)
- RES.0014 Air-data enhanced fault detection and diagnosis
- RMT.0196 Update of the flight simulation training device requirements
- RMT.0118 Analysis of on-ground wing contamination effect on take-off performance degradation

A close cooperation with EASA and with notational aviation authorities during the implementation of this project should be ensured.

Other Actions

Grants to identified beneficiaries

Support to European Standardisation Organisations for the development of an improved test method for heat pumps

Heat pumping is a key technology for the future of heating in the building sector; heat pumps will supply a sizeable share of the heat to satisfy buildings needs in the future. Heat pump product energy efficiency is a key parameter for the uptake of heat pumps and it will also influence future energy demand for heating of buildings. Heat pump energy efficiency is regulated through ecodesign (Regulation (EU) n°813/2013) and energy labelling (Regulation (EU) n°811/2013) regulations. Harmonised standards, which are reliable, accurate, reproducible, and representative of real-life use are important for product energy efficiency regulations to be applied and enforced. In the context of the revision of the previously mentioned regulations, discussions are on-going to improve the present test method. With the present test method, the average energy efficiency (calculated in standard EN14825) is obtained by weighting the results of steady state tests obtained by setting the unit control in specific modes following manufacturer instructions (according test method defined in EN14511-3); it means that the impact of the control of the unit on the energy efficiency is not fully considered and that it cannot be ensured that the set points tested are really part of the normal functioning of the machine. In order to improve the situation, a new and dynamic methodology has been proposed, which is known as the load-based testing or compensation method. However, it was never used in a regulatory context, nor in Europe or elsewhere. This method is presently being developed within the CEN TC113/WG8 as part of standard EN14511-3.

This grant will be awarded without a call for proposals according to Article 195(e) of the Financial Regulation and Article 20(4) of the Horizon Europe Framework Programme and Rules for Participation to the legal entity identified below as it follows up this previous work within the CEN TC113/WG8 in which knowledge gaps were identified. Indeed, before this new test method can be implemented by the EU in a regulatory context, it must be ensured that it is representative (shows realistic performance compared to real life), reproducible and repeatable. In that direction, a Round Robin Test is necessary to validate the method. It is also necessary to identify product subtypes whose control configuration or other characteristics would make it impossible to test with this method. This action is necessary and urgent for the EU to be able to use this improved test method in a regulatory context. If this new test method is adopted without asserting the identified knowledge gaps, problem may appear after the new test method has been adopted leading to problems in the enforcement of heat pump ecodesign and energy labelling regulations. Without this action, stakeholders are likely to remain undecided on the test method to be used with the risk of paralyzing the regulatory process.

Legal entities:

AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH - Giefinggasse 4, 1210 Vienna (Austria); BOSH Robert Bosch GmbH | Postfach 13 09 | 73243 Wernau (Germany); Building Research Establishment Limited - Bucknalls Lane, Garston, Watford, Herts, WD25 9XX (UK); CEIS -Ctra. Villaviciosa de Odón a Móstoles, 28935 Móstoles (Madrid) (Spain); CETIAT - 25 Avenue des Arts, 69100 Villeurbanne (France); Daikin Europe N.V. - Zandvoordestraat 300, 8400 Oostende (Belgium); DAkkS - Am Ohrberg 1, 31860 Emmerthal (Germany); Danish Technological Institute - Gregersensvej 1, 2630 Taastrup (Denmark); ECOS - c/o WeWork Rue du Commerce 31 1000 Brussels, Belgium; ENGIE Lab CRIGEN - 4 Rue Joséphine Baker, 93240 Stains (France); Eurac Research - Drususallee/Viale Druso 1, I-39100 Bozen/Bolzano (Italy); Fraunhofer ISE - Heidenhofstrasse 2, 79110 Freiburg (Germany); Groupe Atlantic - 13, Bd Monge - ZI - BP 71 - 69882 MEYZIEU CEDEX (France); Heating Performance Lab GmbH - Rosberg 24, 52074 Aachen (Germany); ILK Dresden - Bertolt-Brecht-Allee 20, 01309 Dresden (Germany); Mitsubishi Electric - ZAC des Hautes Patures Imm Nacarat, 15 rue du 1er mai, 92000 Nanterre (France); NIBE group - Hannabadsvägen 5, 285 32 Markaryd (Sweden); Panasonic R&D Center Germany GmbH (PRDCG) - Monzastr. 4c, 63225 Langen, Germany; Politecnico di Milano - RELAB Laboratory - Energy Department - Via la Masa 34, 20156 Milano (Italy); RWTH Aachen University - Mathieustraße 10, 52074 Aachen (Germany); Universität Stuttgart, IGTE - Prüfstelle HLK Pfaffenwaldring 6A 70569 Stuttgart (Germany); Viessmann Climate Solutions SE - Viessmannstrasse 1, 35108 Allendorf/Eder (Germany).

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

Indicative timetable: 1st quarter of 2025

Indicative budget: EUR 2.00 million from the 2025 budget

Prizes

Place Holder: Prize - Lithium production from geothermal plants in Europe

Prize aim:

The aim of this prize is: the on-site demonstration of lithium production (lithium carbonate – Li_2CO_3 or lithium hydroxide – LiOH) from geothermal brines in a geothermal plant subject to meeting the eligibility requirements outlined below (Eligibility requirements).

Expected results:

Lithium has been classified as a “Critical Raw Material” by the EU, as it is used in batteries, which are a key enabler of the clean energy transition, given the important role they play in

the rollout of zero emission mobility and the storage of intermittent renewable energy. As demand for Lithium-ion batteries is expected to increase dramatically soon, a stable and sustainable supply of lithium is of utmost importance.

Geothermal plants can potentially apply Direct Lithium Extraction (DLE) technologies and produce lithium, and other critical minerals, from geothermal brines. But the widespread development and adoption of DLE systems is still subject to ongoing research, technological advancements, and economic viability.

The prize competition is expected to stimulate progress in the field by advancing DLE technologies, and to commence and increase the amount of lithium produced in Europe's geothermal plants.

The prize competition also attempts to increase the visibility of and public support for DLE technologies, and to generate interest from investors and from stakeholders in the lithium mining industry.

The prize winner will be the participant that will have demonstrated on-site lithium production from geothermal brines, while at the same time ensuring the greatest level of efficacy, efficiency, technological advancement and innovation, sustainability, profitability, and replicability of the technology.

The prize winner is required to host the Jury on-site at the geothermal power plant to perform lithium production through an on-site demonstration of the DLE technology in operation.

Eligibility criteria:

The contest is open to all legal entities (including natural persons) or groups of legal entities regardless of its place of establishment.

Contestants must demonstrate production of lithium from geothermal brines through DLE technology integrated in a geothermal plant based within the borders of the European Union or of associated countries to Horizon Europe.

Award criteria:

The prize will be awarded, after closure of the contest, to the entry that in the opinion of the Jury demonstrates a solution that best addresses the following cumulative criteria: technical ability, sustainability, economic performance and scalability. The prize competition will be undertaken in two stages: (1) desk-based evaluation; and (2) on-site evaluation to demonstrate the production of lithium.

Type of action: Inducement Prize

Reward & Prize Amount:

The total money allocated to this prize is €7 million (EUR 7.000.000) to be distributed as follows:

1st place: €4 million

2nd place: €2 million

3rd place: €1 million

Time: Launch Q2 2025, Award Q4 2028

Place Holder: Prize – Renewable energy technology (RET) solutions in energy communities

Prize aim:

This prize aims to highlight the different participatory and governance innovations within energy communities while operating a RET. While addressing (common) shortcomings, challenges and/or energy poverty, both innovative governance structures, participation methods and social procedures during the implementation and operation of RET in Energy Communities will need to be showcased.

Expected results:

Individual energy communities encounter different challenges, such as developing a successful governance structure that is sufficiently inclusive and includes different types of actors, carrying out an effective business model and embedding activities within the structure and management of the EC to territorial regional and/or local plans (e.g. Just Transition Plans, etc.).

By rewarding Energy Communities' innovative governance structure and management of a RET, the prize aims to inspire other Energy Communities to improve their operations and implementation activities and to foster innovativeness in the compliance of climate goals. In addition, this prize will also serve as inspiration and example to other types of communities to become an energy one, accelerating the pace for the ones that are already being formed/developed.

The prize will showcase the best practices from the awarded communities to other ones experiencing similar challenges and issues, portraying a (replicable) framework on how to address these issues successfully. In this way, communities will feel incentivized to apply these practices, to improve their performance, management, etc., and so they can participate in future (similar) prize calls.

Since Energy Communities have encountered bottlenecks in terms of management, governance structure, provision of other services, etc., this prize will aid to portray the successful ones on how to develop/carry out a fruitful business model that includes and promotes different type of services, while including and improving social aspects within the community.

While showcasing governance innovativeness within the common barriers encountered to operate, the awarded communities will present a clear example that can serve as a replicable framework for other communities on how to overcome challenges and barriers, and address encountered common bottlenecks.

Eligibility criteria:

The contest will be open to all Energy Communities that fall into the definitions and concepts of the Energy Communities Repository, which identifies renewable Energy Communities and Citizen Energy Communities as defined in the Renewable Energy Directive and in the Internal Electricity Market Directive. The do not need to be legally formed yet but can be in the process of it. In addition, only energy communities with up to 10,000 members will be eligible.

Award criteria:

The prizes will be awarded, after closure of the contest, to the entries that in the opinion of the Jury demonstrates excellence within their governance structure, demonstrating innovativeness in addressing common challenges of Energy Communities: inclusivity, internal governance, regional/local approach and other innovative approaches. The prize will be divided into two steps: 1) first round of selection: evaluation of the first three criteria and selection of ten prize winners and second round of selection: selection of the best three within the 10 winners by assessing the bonus points.

Type of action: Recognition Prize

Reward & Prize Amount:

The total money allocated to this prize is €1 million (EUR 1.000.000) to be distributed as follows:

- 1st place: €350.000
- 2nd place: €200.000
- 3rd place: €100.000
- 4th place to tenth place: €50.000

Time: Launch Q3 2025, Award Q4 2026

Place Holder: Prize - Advanced digital solutions to improve maintenance processes of renewable energy technologies (RET)

Prize aim:

Operation and maintenance (O&M) practices are critical in enabling and sustaining energy activities. They ensure the efficiency and longevity of energy assets, such as power plants, turbines, or solar panels. In the context of Renewable Energy Technologies (RET), O&M presents several challenges that demand attention. It includes complex and time-consuming processes, downtime of assets, maintaining energy availability, and economic impacts. Moreover, enhancing O&M practices potentially leads to further circularity, extension of the lifespan of energy assets, and reduction of waste. As we strive to achieve widespread adoption of renewable energies and greater circularity in energy systems, improving O&M practices becomes paramount.

Recent digital innovations have sparked new advancements in O&M, offering promising avenues for more efficient and sustainable means of managing renewable energy-generating assets. Existing digital solutions are contributing to the reduction of O&M costs, which are the primary ongoing expenses for RET after the initial investment. Cost reductions can be achieved by improving predictive maintenance and via optimised implementation of O&M activities. Solutions like drones also hold the potential for improving health and safety of O&M workers. Lastly, digital solutions can enhance the environmental impact of RET by increasing the life span of energy assets, reducing waste, and monitoring impacts on the ecosystem.

The recognition prize will reward existing advanced digital solutions to improve O&M processes for RET. By fostering collaboration, visibility, and investment in cutting-edge solutions, it will contribute to O&M's operational efficiency, reducing its costs, saving employees working time and improving their health and safety working conditions, as well as enhancing the sustainability of the RET system.

Expected results:

The prize winners will be the entrants that have developed digital solution(s) that demonstrate the best improvement in terms of performance, energy availability, cost-efficiency, carbon footprint, and health and safety conditions. Moreover, the solution will prove its utility, demonstrating how it addresses existing gaps in the RET market and fulfils its essential need for improvement.

Showcasing such solutions will serve as inspiration for other companies as well, motivating them to adopt similar O&M approaches. Promoting the solutions, the prize will help to enhance the competitiveness of renewable energy technologies against other non-renewable sources of energy production. More generally, the prize will benefit the RET sector, encouraging the adoption of RET, and simultaneously mitigating environmental impact for a more sustainable future.

Eligibility criteria:

The contest is open to all legal entities (including natural persons) or groups of legal entities regardless of its place of establishment.

Only digital technologies that are applied to renewable energy technologies may participate. Digital solutions comprise both software and/or hardware. Renewable technologies include photovoltaics, concentrated solar power, wind power (on-shore and off-shore), bioenergy, renewable fuels, ocean energy systems, hydropower, geothermal, and renewable heating and cooling. Solutions covering several RET and hybrids are eligible. The RET system the solutions apply to can be of any size, from an individual piece of generating equipment to a large plant scale.

Contestants should have already demonstrated a prototype of their solution in a relevant environment, which is applicable to renewable energy technologies.

Award criteria:

The prize will be awarded, after closure of the contest, to the solution that best addresses the following cumulative criteria: improved performance and deployment potential. Results will be scored a posteriori according to the relative performance across all applications. Scores will be assigned a posteriori comparing the parameters among all applications, with the leading application receiving the highest points. For the applications for which parameters lack sufficiently detailed methods and measurement descriptions will not be awarded any points for these parameters. The prize competition will be undertaken according to two stages: (1) desk-based evaluation; and (2) Grand Final to test device performance.

Type of action: Recognition Prize

Reward & Prize Amount:

The total money allocated to this prize is €1.8 million (EUR 1.800.000) to be distributed as follows:

- 1st place: €1.000.000
- 2nd place: €500.000
- 3rd place: €300.000

Time: Launch Q4 2025, Award Q4 2027

Public Procurements

CCUS knowledge sharing platform

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: 2nd quarter 2025

Indicative budget: EUR 3 million from the 2025 budget

Expected outcomes:

A growing number of CCUS projects are on track to become operational before 2030. The Communication on Industrial Carbon Management [77] emphasises the importance of aggregating these industrial-scale projects into a knowledge-sharing platform to facilitate the collection of information on and best practices between CCUS projects in the EU. This procurement is expected to establish and operate an open collaboration and knowledge sharing platform, providing data and up-to-date information about the entire CCUS sector, based on the collection of primary data from current and future large-scale demonstration projects.

Scope:

The knowledge sharing platform will be open to all projects (at industrial scale, but also larger research and pilot demonstrations) that are ready to share information and cooperate without disclosing commercially sensitive information and in full compliance with single market competition rules. Depending on the type of project, the knowledge sharing platform shall collect and display data on deployed technologies and storage site characteristics as well as best practices from the projects, such as project governance (including management of interphases and risks, involvement of operating organisation of facility[78]), barriers and success factors, needs for standards, access to funding, stakeholder management, regulatory aspects and permitting issues. It will also cover lessons learned on public engagement and on sharing best practice of dialogues between project developers, local and national authorities. The data and information must be displayed in a user-friendly way in order to be easily accessed by industry stakeholders, managing authorities, policy-makers, researchers and citizens.

Indirectly managed actions

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-

[77] https://energy.ec.europa.eu/document/download/6b89e732-fea4-480b-9d2e-cf64de90247e_en?filename=Communication_-_Industrial_Carbon_Management.pdf

[78] https://ccsnorway.com/sharing-important-learning-from-building-a-ccs-facility-in-an-operating-plant/

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 Projects[79], 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 Strategy[80] 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 Alliance[81], 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 CO_2 emissions in the EU in 2018, it accounted for 15.7% of CO_2 transport emissions. 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 that zero-emission aircraft configurations and powertrain

79 https://www.eib.org/en/products/mandates-partnerships/innovfin/products/energy-demo-projects.htm

80 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301

81 https://ec.europa.eu/growth/industry/policy/european-clean-hydrogen-alliance_en

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 initiative[82] 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*[83] 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).

82 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))

83 Renewable Fuels of Non Biological Origin (RFNBOs) as defined under RED II.

- *Direct air capture (DAC) of CO_2.* 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 CO_2 point capture and 200 Mt of CO_2 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 CO_2. 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.

- *Decarbonisation of Industry (steel and cement).* Rapid innovation is needed to bring to market clean technologies for those parts of the energy system where emissions are harder to address, in particular carbon intensive industries (e.g. steel, cement, chemicals, aluminium, ceramics). Carbon capture, utilisation and storage (CCUS) will play an important role in mitigating those hard-to-abate process emissions. In March 2023 the European Commission introduced the Net Zero Industry Act, which identifies CCUS as a strategic net zero technology for which scaling up of manufacturing capacity is critical to reaching the EU's climate goals. Specifically, the Act proposes to set an EU-wide goal to achieve an annual CO2 injection capacity of 50 Mt by 2030, with oil and gas producers asked to contribute, in addition to setting clear timelines for permitting CCUS projects. While CCUS technologies have been demonstrated in various settings and on certain scales, it is still a challenge to scale up these technologies for widespread use, understand their performance and requirements and develop the best models for their deployment. This is due to factors such as energy efficiency, cost of capture technologies, and the technical feasibility of transporting and storing large volumes of CO2.

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 2025

Indicative budget: EUR 50.00 million from the 2025 budget