Destination – Sustainable, secure and competitive energy supply

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

The transition of the energy system will rely on reducing the overall energy demand and making the energy supply side climate neutral, in current and future climate conditions. R&I actions will help to make the energy supply side cleaner, more secure, and competitive by boosting cost performance and reliability of a broad portfolio of renewable energy solutions, in line with societal needs and preferences. Furthermore, R&I activities will underpin the modernisation of the energy networks to support energy system integration, including the progressive electrification of demand side sectors (buildings, mobility, industry) and integration of other climate neutral, renewable energy carriers, such as clean hydrogen. Innovative energy storage solutions (including chemical, mechanical, electrical and thermal storage) are a key element of such energy system and R&I actions will advance their technological readiness for industrial-scale and domestic applications. Carbon Capture, Utilisation and Storage (CCUS) is a CO_2 emission abatement option that holds great potential and R&I actions will accelerate the development of CCUS in electricity generation and industry applications.

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

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

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy*[139] *by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*

It covers the following **impact areas**:

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

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

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

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

i. Fostering European global leadership in affordable, secure and sustainable **renewable energy technologies** and services by improving their competitiveness in global value chains and their position in growth markets, notably through the diversification of the renewable services and technology portfolio (more detailed information below).

ii. Ensuring cost-effective uninterrupted and affordable supply of energy to households and industries in a scenario of high penetration of variable renewables and other new low carbon energy supply. This includes more efficient approaches to managing **smart and cyber-secure energy grids** and optimisation the interaction between producers, consumers, networks, infrastructures and vectors (more detailed information below).

iii. Accelerating the development of **Carbon Capture, Use and Storage (CCUS)** as a CO_2 emission mitigation option in electricity generation and industry applications (including also conversion of CO_2 to products) (more detailed information below).

Global leadership in renewable energy

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

It is imperative to enhance affordability, security, sustainability, and efficiency for more established renewable energy technologies (such as wind energy, photovoltaics, solar thermal, bioenergy or hydropower), and to further diversify the technology portfolio. Furthermore, advanced renewable fuels, including synthetic fuels (which contain also direct solar fuels[140]) and sustainable advanced biofuels, are also needed to provide long-term carbon-neutral solutions for the transport, energy consuming and energy-intensive industrial sectors, in particular for applications where direct electrification is not a technically and cost-efficient option.

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

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

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

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

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

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

- **PV, wind energy and heat pumps**, encompassing the most readily available renewable energy technologies to reduce the EU's dependence on fossil fuels. (17 topics)

- **Renewable fuels**, encompassing the most readily available technologies (advanced biofuels) but also the less mature ones (synthetic renewable fuels). Renewable fuels can be used in transport but also in buildings and industry to meet the demand for electricity and heat, therefore displacing fossil fuels. Gaseous renewable fuels are one of the named actions in the REPowerEU communication, as regards increasing the production of bio methane twice above the European Green Deal target in 2030. All forms of renewable fuels, and in particular advanced biofuels, contribute to reduce the EU's dependence, because they are drop-in fuels and direct replacements of fossil fuels, utilizing the existing infrastructure. (8 topics)

- The remainder of the topics also contributes to the objective of **decreasing the EU's dependence on fossil fuels,** with the focus either on specific renewable energy sectors (bioenergy, geothermal, hydropower, ocean energy and solar thermal) or on cross-technology activities (next generation renewable energy, market measures, international cooperation). (18 topics)

Main expected impacts:

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

- Reduced cost and improved efficiency of sustainable renewable energy and renewable fuel technologies and their value chains.

- Support de-risking of sustainable renewable energy and fuel technologies with a view to their commercial exploitation to contribute to the 2030 "Fit for 55" targets increasing the share of renewable electricity, heat and fuels in the EU energy consumption (in particular, 40% renewable energy overall, 2.2% advanced biofuels and 2.6% renewable fuels of non-biological origin).

- Better integration of sustainable renewable energy and renewable fuel-based solutions in all economic sectors, including through digital technologies.

- Enhanced security and autonomy of energy supply in the EU, while accelerating the green transition.

- Affordable, secure and sustainable energy solutions to diversify gas supplies in the EU by increasing the level of biomethane.

- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).

- Enhanced sustainability of renewable energy and renewable fuels value chains, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

- More effective market uptake of sustainable renewable energy and fuel technologies to support their commercialisation and provide inputs to policy making.

- Increased knowledge on the environmental impacts of the different renewable energy technologies along their lifecycle and value chains.

Energy systems, grids and storage

Main expected impacts:

- Increased resilience of the energy system, based on improved and/or new technologies and energy vectors, to control the system and maintain system stability under difficult circumstances.

- Increased flexibility and resilience of the energy system to plan and operate different networks for different energy carriers simultaneously in a coordinated manner that will also contribute to climate neutrality of hard-to-electrify sectors.

- Innovative data-driven services for consumers that empower them to engage in the energy transition. Enhanced consumer satisfaction and increased system flexibility thanks to enabling consumers to benefit from new energy services and facilitating their investment and engagement in the energy transition.

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

Carbon Capture, Utilisation and Storage (CCUS)

Main expected impacts:

Carbon capture, utilisation and storage (CCUS)

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

- Adequate frameworks for Measurement, Monitoring and Verification (MMV) for storage and use projects, to document safe storage and for public buy-in of the technology.

- Further research in DACCS and BECCS as CO2 capture technologies in combination with CO2 storage in order to deliver carbon removals.in view of achieving the net zero targets.

- Assess the environmental impacts and risks, in the short, medium and long term, of CCUS technologies, with respect to the Do No Significant Harm principle, and to inter-generational solidarity.

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

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

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-01

Conditions for the Call

Indicative budget(s)[141]

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

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

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

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

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

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

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

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

06		148			
HORIZON-CL5-2023-D3-01-07	IA	18.00 149		Around 9.00	2
HORIZON-CL5-2023-D3-01-08	IA	40.00 150		Around 20.00	2
HORIZON-CL5-2023-D3-01-09	IA	12.00 151		Around 6.00	2
HORIZON-CL5-2023-D3-01-10	IA	20.00 152		Around 20.00	1
HORIZON-CL5-2023-D3-01-11	IA	18.00 153		Around 9.00	2
HORIZON-CL5-2023-D3-01-12	IA	22.00 154		Around 11.00	2
HORIZON-CL5-2023-D3-01-13	RIA	14.00 155		4.00 to 5.00	3
HORIZON-CL5-2023-D3-01-14	IA	30.00 156		Around 10.00	3
HORIZON-CL5-2023-D3-01-15	IA	18.00 157		Around 18.00	1
HORIZON-CL5-2023-D3-01-16	CSA	0.60		Around 0.60	1
HORIZON-CL5-2023-D3-01-17	IA	40.00 158		Around 20.00	2
HORIZON-CL5-2023-D3-01-18	COFUND	48.50	22.50	Around 71.00	1
Overall indicative budget		401.10	22.50		

148 Of which EUR 10.10 million from the 'NGEU' Fund Source.
149 Of which EUR 10.10 million from the 'NGEU' Fund Source.
150 Of which EUR 22.40 million from the 'NGEU' Fund Source.
151 Of which EUR 6.00 million from the 'NGEU' Fund Source.
152 Of which EUR 11.20 million from the 'NGEU' Fund Source.
153 Of which EUR 10.10 million from the 'NGEU' Fund Source.
154 Of which EUR 12.30 million from the 'NGEU' Fund Source.
155 Of which EUR 7.80 million from the 'NGEU' Fund Source.
156 Of which EUR 16.80 million from the 'NGEU' Fund Source.
157 Of which EUR 10.10 million from the 'NGEU' Fund Source.
158 Of which EUR 22.02 million from the 'NGEU' Fund Source.

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

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-01: Renewable Energy Valleys to increase energy security while accelerating the green transition in Europe

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
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:

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

- Contribute to the implementation of the REPowerEU Plan, in particular to i) diversify gas supplies via higher levels of sustainable bio-methane (mainly based on organic waste and agricultural residues) and green hydrogen, and ii) speed up Europe's path to independence from fossil fuels by increasing the share of renewable energy (electricity, heat and fuels) in the European energy consumption.
- Increase the roll-out of local or regional renewable energy system solutions for electricity, heat and fuel needs and contribute to their market up-take in Europe.
- Create new sustainable jobs linked to local or regional renewable energy system value chains and enhance economic growth in local or regional European communities.
- Enhance security and autonomy of local or regional energy supply in EU Member States/Associated countries in current and future climate conditions.
- Increase the readiness, reliability, performance and affordability of local or regional renewable energy system solutions in Europe.

Scope: The EU energy system strongly relies on centralised electricity generation and on fuel imports, with 95% of its oil and 84% of its gas consumption sourced from outside the EU. The REPowerEU Plan proposes a set of actions to reduce the EU's dependence on fossil fuels and diversify its energy supply 'well before 2030'. The three pillars of the plan are to ramp up the production of green energy, diversify our energy supplies, and reduce our demand for fossil gas, coal and oil.

Renewable energy valleys are understood as decentralised renewable energy systems that offer a viable and efficient solution to the challenges mentioned above. For example, local production and consumption, reduced transmission and distribution losses thanks to the reliance on local networks for energy needs, greater operational flexibility and reduced dependence on expensive fuel imports all contribute to a higher energy autonomy, a more secure supply, and lower, more stable overall energy costs, including for individual citizens. In addition, this alleviates a part of the load on the centralised grid and avoids blockages by the capacity of the grid.

Proposals are expected to address the following aspects:

- Creation of a renewable energy valley 'living lab' in local, peri-urban or regional communities that demonstrates in real life conditions the sustainable and cost-effective

production and storage of renewable energy from different local renewable energy sources providing multiple renewable energy carriers (e.g., electricity, heat, renewable fuels, bio-methane, biogas, hydrogen), fully covering the local energy needs on an annual basis.

- Consideration of different potentials in terms of geography, climate and natural resources in the concept design.
- Consideration of different end users (e.g. buildings, mobility, industry, industrial parks) of the multiple renewable energy carriers.
- Reduction of energy use and energy losses through the integration of effective and innovative energy-efficient solutions.
- Development and testing of a digital twin of the specific local energy grid for all types of energy carriers (i.e., electricity, heat, fuels including gases) for operational analysis, detailed energy forecasting and local grid management.
- Scenario analysis using the digital twin to constantly improve multiple carrier grid management, planning, data gathering/handling and cyber security.
- Development of cost-effective upscaling and commercialisation approaches of the solutions, linked to robust business models along the value chains, considering inclusive and affordable access to energy for consumers. This can include collaborative ventures with local stakeholders.
- Regarding the development of the renewable energy technologies value chains, fostering the participation of the local industry and other stakeholders, including citizens, Energy Communities and the Energy Communities Repository [159] as appropriate, therefore generating local jobs, skills, economic growth and benefits for citizens. As such, providing support to the participation of citizens in the design, implementation and exploitation of renewable energy, in order to increase acceptability. Where applicable, synergies with other economic sectors than the energy sector may be considered.
- Regarding the local or regional renewable energy system developed, assessment of its stability, robustness, and fitness to the local resources and needs, including understanding consumer behaviour.
- Assessment of costs avoidance from fossil fuels imports in line with REPowerEU to decrease the dependence on such imports.
- Assessment - both at the design phase and during operation - of environmental and socio-economic impacts (positive and negative) for the local community or region, and development of measures to mitigate the negative impacts.

[159] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

The renewable energy valleys can take diverse configurations, such as peri-urban settings, (agro-) industrial clusters or remote or islanded areas. They can also take the form of either distinct but combined systems or unique poly-generation systems (i.e., in the same infrastructure) to deliver multiple energy carriers from combined renewable energy resources and technologies.

The proposal should indicate how the operation and maintenance of the living lab will be guaranteed after the end of the project.

Technological developments for hydrogen production and storage are addressed in the frame of the Clean Hydrogen European Partnership and are therefore excluded from this call, but proposals may include the integration of such devices in the demonstration.

Proposals are expected to foresee coordination and collaboration with similar EU-funded projects (in particular, those that will be funded under this topic) for policy relevant issues such as regulatory framework, business models and obstacles to innovation.

HORIZON-CL5-2023-D3-01-02: PV integration in buildings and in infrastructure

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
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: Photovoltaic products are considered to be building-integrated, if they have been designed following the basic requirements for construction works in order to form and/or replace a construction product. If the integrated PV product is dismounted, it would have to be replaced by an appropriate conventional construction product. Building and infrastructure integrated PV can be a cost-effective, technologically proven solution to decarbonise buildings and infrastructure.

Consequently, project results are expected to contribute to all of the following expected outcomes:

- Demonstrate economic and sustainable integration of PV products in the built environment and in infrastructure.
- Establish enhanced structural collaborative innovation between PV companies and the (building) construction sector.
- Contribute to the Renovation Wave, the Mission on climate-neutral and smart Cities and the New European Bauhaus initiative.

Scope: PV integration in buildings and in infrastructure unlocks a huge potential for renewable electricity generation. Integrated PV require individual solutions in order to meet multi-functional and aesthetic requirements such as yield-friendly colouring or modular transparency, antifouling property, structural flexibility, module lightness and flexibility, suited voltage levels, the use of and combination with (building) materials other than glass, and an overall high aesthetical value that addresses the requirements of architects and designers.

Proposals are expected to:

- Demonstrate resilience against partial shading, flexibility in the interconnection of PV modules having different sizes and electrical characteristics specific optical and thermal control solutions, long service life/easy replacement, safety and simplicity of maintenance, software control for quick detection of faults, module substructures and fixing systems to enhance aesthetics and functionality of the integration and electricity yield.
- Decrease costs and enhance lifetime, quality, reliability and sustainability with new approaches for both PV module and BOS with the development of industrialized production of customized products and of prefabricated modular solutions, which incorporate an integrated life cycle approach.
- Develop energy integration and social behaviour concepts to maximize the energy matching between PV production and local buildings consumption, supported by new tools and business models to ensure their economic effectiveness.
- Demonstrate integration of PV design and manufacturing within the construction value chain with appropriate consideration to standards for buildings and infrastructure, as well as contribution to new and improved standards.
- Form alliances between all stakeholders (PV and building/construction sectors, distribution system operators, investors, owners, architects, installers) to tackle a number of educational and regulatory barriers that still hinder the development of integrated PV in buildings and in infrastructure. The goal is to promote new concepts/schemes and business models for an active role of integrated PV in renovation and construction.

Demonstrations are expected to be carried out in more than one different construction typologies (residential buildings, tertiary building [hospitals, schools, public administration buildings, etc.]), or civil infrastructures (roadways, noise barriers, parking lots, bridges, etc.) and in more than one location in Europe.

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

Projects are expected to contribute to the New European Bauhaus (NEB) initiative[160] by interacting with the NEB Community, NEBLab and other relevant actions of the NEB initiative through sharing information, best practice, and, where relevant, results.

HORIZON-CL5-2023-D3-01-03: Floating PV Systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
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: Photovoltaic power generation is pivotal to a clean energy system and the achievement of the net zero-emissions target. To this end, it is important to enhance affordability, sustainability and exploit the modularity and synergies of application of PV technologies.

Consequently, project results are expected to contribute to all of the following outcomes:

[160] https://europa.eu/new-european-bauhaus/index_en

- Expand the potential application and minimise the environmental impact of Floating PV (FPV) technology for inland and offshore waters.

- Significant improvement of FPV designs that reduce both CAPEX and OPEX, maximize energy output and thus reduce LCoE.

Scope: Floating PV (FPV) has huge potential in uncovered waterbodies, presenting an opportunity for solar energy production in areas where difficult terrain or land constraints make ground-mounted systems impractical. However, FPV also face a plethora of challenges for various environmental conditions such as wind, wave, currents, water level variations and humid and corrosive environment that could adversely affect the electrical output and life of the plant.

Proposals are expected to:

- Develop (and verify) predictive yield models including dynamic behaviour of the PV floats, temperature effects and wave induced mismatch losses, depending on the application environment (wave height class) and scale of implementation.

- Demonstrate advanced module and system concepts of adequate scale (min 5 MW) for electrical output optimisation considering the disturbance of environmental factors to the electrical output characteristics of PV modules and systems.

- Demonstrate system components that satisfy the structural and functional requirements for the entire lifecycle (coping with soiling and fouling, degradation, corrosion, environmental stress cracking, UV stabilisation, exposure to water, salinity, humidity, algae growth, toxicity). Address reliability and performance loss rates through the development of accelerated stress testing specifically for FPV applications, operational data, and visual inspection of FPV systems.

- Demonstrate low impact on ecosystem biodiversity by developing methodologies (models, monitoring…) and guidelines to assess the direct impacts of FPV on aquatic systems and biodiversity and consider potential mitigation measures.

- Satisfy end-of-life recycling aspects.

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

HORIZON-CL5-2023-D3-01-04: Solar Systems for Industrial Process Heat and Power

Specific conditions	
Expected EU	The Commission estimates that an EU contribution of around EUR 7.00

contribution per project	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
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: Renewable energy integration in the industrial sector is a key step in achieving low-carbon production systems. Solar systems for industrial process heat and power are gaining attention towards this goal and have the potential for significant scale up, particularly in areas that combine a large and diverse industrial sector with rich solar resources. Therefore, project results are expected to contribute to the following expected outcome:

- Energy efficient solar resource integration in the industrial sector for achieving low-carbon, emission-free production systems.

Scope: Industrial processes need considerable amounts of heat and power. Much of the demand for process heat, roughly 50% among the most energy-intensive manufacturing industries, including food and beverages and pulp and paper, occurs at temperatures of 400 °C or less. The Solar Thermal (ST) medium-temperature process heat or cogeneration with electricity can be an effective way to transition to clean energy sources and displace conventional fossil fuel use in industry. On the other side, Photovoltaic (PV) systems convert sun-light to direct current (DC) electricity and the electricity can be used to power or heat industrial processes directly (or via the grid) with electric heating technologies. The two solar technologies (PV and ST) are not competing but can be suitably integrated in an energy system to best benefit of the different features offered by the two options. This high synergy output would allow a useful integration of solar in many industrial processes.

Proposals are expected to:

- Demonstrate a system that considering solar energy's generation potential, topographic characteristics, land-use constraints and system performance, generates solar medium-temperature heat and electricity in a modular, low environmental footprint, low cost and high-efficiency hybrid PV and ST design. Optimize the manufacturing processes based

on the process integration concept (presenting opportunities for energy efficiency and heat recovery) and process control, to reduce process power and heat demand to its practical minimum for an energy efficient solar energy supply (possibly including storage) investment.

- Demonstrate the potential of hybrid approaches (PV and ST) that produce heat and electricity to power a broad range of manufacturing end uses. A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2023-D3-01-05: Critical technologies for the offshore wind farm of the Future

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Improved performance of offshore wind turbines and efficient use of the marine space.
- Reinforced European offshore wind turbine value chain, supporting local companies and creating local jobs and skills.

- Reduce the possible impacts of offshore wind turbines on protected species and habitats.
- Reduced use of primary raw materials and reduced dependency on scarce raw materials.
- Reduction of LCOE and increased sustainability.

Scope: The objective is to bring major innovations in the design and manufacturing of large offshore wind farms, aiming at >15 MW for fixed bottom offshore applications and >12 MW for floating offshore installations.

Attention can be paid to substantially reducing the wind turbine mass (rotor/nacelle/tower) as well as on advanced lean marine-compatible substructures, advanced (dynamic) cabling and connectors, including floating platforms and its moorings. Innovations such as compact generators, smart blades, reliable drive trains, can be investigated alongside new turbine designs. Innovative low-cost substructures with suitable geotechnical and hydro-dynamic properties should be developed using long-lasting, anti-fouling, corrosion resistant materials with high damping properties.

The projects should exploit improved understanding of the issues related to materials in the upscaling of wind energy turbines/systems (stresses and strains, delamination, etc.)

The innovations should contribute to sustainability considering circularity in the design phase, less (or no) use of (critical) raw materials and decreasing negative environmental and social impacts. They should also contribute to the mitigation of the possible impacts to protected species and habitats.

Such development will allow further deployment of offshore wind energy conversion systems and dramatically increase the offshore wind potential while reducing public acceptability barriers (noise, visual impact).

The active participation of relevant industrial partners and technology suppliers is essential to form a multisectoral, multidisciplinary consortium able to achieve the full impact of the project.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that describes that further R&I action is needed in critical raw material substitution, reducing the environmental impacts of offshore technologies, and job creation.

HORIZON-CL5-2023-D3-01-06: Demonstration of advanced biofuel technologies for aviation and/or shipping

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
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.
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). [161].

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

- Expand the technology portfolio for ready to pre-commercial plant investments in advanced biofuel technologies for aviation and /or shipping.
- Support de-risking the technology, boost scale-up of advanced biofuels for aviation and /or shipping and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in aviation and /or shipping.
- Support better integration of advanced biofuel technologies in aviation and /or shipping.

Scope: Demonstration of technological pathways for the production of liquid jet-drop-in and/or liquid bunker drop-in advanced biofuels with reduced cost and GHG emissions from biogenic residues and wastes including CO2 or microalgae (including cyanobacteria) through chemical, biochemical, biological and thermochemical pathways, or a combination of them.

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

A reduced cost or at least cost parity with existing biofuels for use in aviation and/or shipping is expected, as for example the hydro processed esters and fatty acids (HEFA) for aviation and the biodiesel for shipping. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

GHG reduction from fossil equivalents above the state of the art should be shown.

The sustainability and GHG reduction should be addressed on a life-cycle assessment basis.

HORIZON-CL5-2023-D3-01-07: Demonstration of synthetic renewable fuel for aviation and/or shipping

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
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:

- Expand the technology portfolio for ready to pre-commercial plant investments in synthetic renewable fuel technologies for aviation and /or shipping.
- Support de-risking the technology, boost scale-up of synthetic renewable fuel for aviation and /or shipping and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in aviation and /or shipping.

- Support better integration of synthetic renewable fuel technologies in aviation and /or shipping.

Scope: Demonstration of innovative technological pathways for the production of synthetic renewable fuels for aviation and /or shipping from renewable energy, CO2, and/or renewable carbon, nitrogen, hydrogen or their compounds, as for example renewable synthetic paraffinic kerosene, renewable methanol/methane and renewable ammonia. Pathways via production of renewable hydrogen or renewable hydrogen ionic compounds from all forms and origins of renewable energy (e.g., electricity, direct sunlight, heat) are in scope. Cost reduction compared to current state of the art including via electricity pathways and above state of the art GHG reduction from fossil fuel equivalents are expected to be shown. An assessment for the scalability potential of the technology, as well as for the overall energy efficiency, the GHG emissions and sustainability based on life cycle analysis should be included. Proposals should provide information and assessment about the economic feasibility of the technology at commercial scale as appropriate The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2023-D3-01-08: Demonstration of sustainable tidal energy farms

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
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 8 by the end of the project – see General Annex B.

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

- De-risking tidal energy technology development and increased bankability/insurability of tidal energy.
- Increased availability and improved market confidence in the technology.
- Increased knowledge on positive and negative impacts of ocean energy on its environment and in the case of negative impacts to protected habitats and species proposals for necessary mitigation measures.
- Publicly available data collected from the demonstration/pilot structure including support structure.

Scope: Demonstration of sustainable tidal energy pilot farms (minimum 4 MW installed capacity and at least 4 devices) in full operational conditions for long periods of time is essential to advance this sector. It is the way to bridge the gap from technology development to market development while reducing costs, reducing risks and attracting investors for future commercial projects. The farm is expected to be composed of several devices of the same series.

The tidal energy farms have to be connected to the electricity grid. To focus on the technologies with the greatest chances of success, the single tidal device to be used in the array deployment is expected to be satisfactorily demonstrated at full scale before, with limited changes to incorporate the learnings. Any change on the tidal device may be incremental but should not involve fundamental changes to the device design or composition.' The innovation component should mainly lie on the pilot farm systems and supporting industrial manufacturing activities that enable a cost-effective and high-performance pilot farm. The project is expected to deploy a tidal energy farm with a minimum capacity of 4 MW and operate the farm at least 2 years in the lifetime of the project. After the project it is expected that the farm will continue to be operated for at least 8 years.

The project should develop and execute an effective operation and maintenance programme.

Proposals are expected to address also all the following for both the supporting infrastructure for the farm and for the individual devices themselves:

- Industrial design and manufacturing processes, circularity of (critical) raw materials, sustainability, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.
- Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Necessary mitigation measures should be integrated to protect habitats and species. Present an environmental monitoring plan to be implemented during the demonstration action. Environmental monitoring data should be open source and be shared with EMODNET and the IEA OES environmental task.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a

techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project, and if needed a plan to achieve certification by an independent certification body before the end of the action. The project proposal is expected to present a clear and convincing pathway to obtain necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. For this the use of other EU/national/regional support mechanisms can be considered. Independent experts will assess all deliverables and will advise for the go/no-go decision.

The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Data from the pilot structures should be collected to understand the performance and behaviour of the structure and the surrounding environmental condition, to optimise the concept and understand the environmental impact of tidal energy harvesting.

The selected projects are expected to contribute to the BRIDGE initiative [162], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-09: Waste heat reutilisation from data centres

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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

[162] https://www.h2020-bridge.eu/

	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 the following expected outcome:

- Make sustainable seasonal storage solutions available to data centres to allow year-round optimised operation in urban environments in an integrated way to supply heat to neighbouring district heating system(s), agriculture and/or industry optimising use of excess heating energy and required cooling energy.

Storage solutions with high round-trip efficiency, low dependence on critical raw materials, low land/space footprint will be considered as advantage.

Scope: Two main obstacles arise in relation to the reuse of waste heat from data centres:

- First, data centres produce more waste heat in summer/when it is hot outside. The PUE (Power use effectiveness) of data centres vary considerably along the year, because in winter they can resort to free cooling (using fresh air from the outside), while in summer they need to ventilate more and use heat pumps to cool down the outside air. As a result, an important part of data centres' waste heat is produced when less people need it (at least for domestic heating purposes).

- Second, the heat produced is of poor quality (low temperatures and often light heat vector), so that even for immediate use it is often not economically viable to use heat pumps to "concentrate" it (increase temperature and, if necessary, communicate it to a heavier vector).

Combining waste heat reuse with heat storage would allow data centres to better valorise their waste heat in winter (under the form of residential heating for instance) while storing this heat during hotter periods. From an economic perspective, the increase of waste heat that can be valorised and sold by the data centre during the appropriate seasons may partially compensate the additional costs of cooling during summer months. Such technologies may subsequently apply to other industries generating important amounts of low temperature – low density heat.

Selected projects will test and further develop seasonal heat storage technologies through an integrated pilot that includes at least the following technologies:

- Heating and cooling exchange system for the data centre and the district heating system.

- Seasonal energy storage.

For efficiency purposes, the storage technology should be able to store the heat for a long time (up to 6 months), with as little energy losses as possible, and using as few compressor steps as

possible. The storage technology should also be non-hazardous and be deployable close to dwelling areas without posing a threat to them. Additionally, a specific consideration should be given to the cyber-physical security of the combined storage and restitution system.

Optionally, the project could involve heat pump manufacturers to explore the benefits of heat pump technologies to the overall heat storage facility.

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

HORIZON-CL5-2023-D3-01-10: Supporting the development of a digital twin to improve management, operations and resilience of the EU Electricity System in support to REPowerEU

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
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:

- Increase the reliability of the energy system by enhancing flexibility and efficiency of the European electricity grid to make it ready for the needed drastic increase of the renewable energy share and more resilient to future shocks (such as cyber-attacks) through scenario analysis and modelling.

- Improve management, maintenance and operations of the EU Electricity System.
- Enhance dynamic monitoring of the energy system, to facilitate energy system integration, information flows, detect anomalies, forecasting demand and to address infrastructure bottlenecks.
- Improve the data exchange between TSOs and DSOs and between network operators and the market players, leveraging data exchange from prosumers.
- Creation of new services for companies and public authorities based on the digital twin.

Scope: To deal with the rising complexity of the Energy System(s), and the impact of the fast-changing energy market reality on the energy system, a digital twin of the electricity grid is a key digital solution to support network operators and market players in performing a well-informed decision-making. It is key tool to accelerate the innovation cycle and to reduce the inertia of the energy sector when it comes to the integration of digital solutions in the energy system in order to make it more efficient, resilient and able to integrate higher shares of renewable energies. Digital transformation of the energy system is thus essential to meet the objectives of REPowerEU.

The project is expected to address all of the following:

- Create, develop and test a Digital Twin of the Electricity Grid that covers dynamic monitoring, (smart) grid planning, secure operation, forecasting and scenario analysis.
- It has to be modular, interoperable and implementable at different scales, integrating both (decentralised) supply and demand-side, taking into account all relevant energy data.
- Promote new ways for energy companies, to share data and break the data-silos - simplifying the data maintenance and exchange process - through a dynamic monitoring of the whole system.
- Synchronize data from various systems, including at least 5 TSO, 5 DSO and 5 market parties that are not related in terms of ownership and with varying levels of infrastructure maturity.
- Standardize it into one multi-user platform via standards-based adapters/interfaces, compliant and integrated with the Common European Energy Data Space.
- Use the Digital twin for multi-facetted resilience scenario analysis to investigate how the electricity grid responds to stimuli or shocks (e.g. RES integration, cyber-attacks) and what answers can be provided.
- Test and pilot the applications of science and innovation in the energy sector (e.g. testing the combination of key digital technologies such as High Performance Computing, Big Data, AI, IoT and Cloud Computing) in order to foster the rapid development new services based on them [e.g. Load Balancing, Power Management, Consumer Services,

Demand forecasting real time and interactive computing]. These new services should help to enhance the flexibility and resilience of the EU energy system.

- Involve key organisations to ensure a European approach is required. In particular, ENTSO-E and DSO associations, as well as main stakeholders such as T&D Europe, Eurelectric, SmartEn, etc.

To ensure interoperability and integration into the grid and the federated European digital infrastructure, specific demonstrators will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy and cross-sector systems being developed under ongoing Horizon 2020, Horizon Europe as well as under other EU programs such as the Digital Europe Program and Connecting Europe Facility.

The selected projects are expected to contribute to the BRIDGE initiative [163], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-11: Demonstration of DC powered data centres, buildings, industries and ports

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
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.

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

[163] https://www.h2020-bridge.eu/

- Demonstrated benefits and efficiency of DC power distribution systems compared to AC (no need of AC/DC conversion, less copper, less space occupancy, etc.).
- Increased reliability and resilience of the grid provided by DC power distribution networks.

Scope: Projects are expected to implement the activities in (1), the practical demonstration in (2) and the recommendations in (3) as described below:

1. Development of R&I activities, methodologies and tools for at least two of the sub-topics (A, B, C or D). These can be developed/complemented among them and/or with others pertinent to each sub-topic:

A. DC powered data centre:

- Design and demonstration of a DC powered data centre. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered data centre as well as to supply other DC loads and to collect the energy of DC sources.
- Integration with the UPS systems, innovative generation, sustainable (hybrid) energy storage, etc.
- Renewable energy systems integration.
- Cost Benefit Analysis of the savings compared with the standard AC powered data centre.
- As a supporting reference for data centres, The EU Code of Conduct Data Centres Energy Efficiency can be used.

B. Application of DC distribution in commercial and residential buildings

- Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered commercial and residential buildings as well as to supply other DC loads and to collect the energy of DC sources.
- Installation of intelligent DC system complete of all the related components (e.g., RES, DC bus, sockets, LED lighting, heat pumps, EV charging stations, sustainable storage systems, etc. The components can be either DC-based or AC-based and appropriately adapted to work within the DC grid.
- Identification of the efficiency of a DC system compared to an AC system in the building sector and the corresponding cost savings.
- Analysis and identification of the main barriers (technical and non-technical) for the development and deployment of MVDC and LVDC systems.

C. Application of DC distribution in industry

- Development and demonstration of DC manufacturing process installation, protection and device technologies. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered industry as well as to supply other DC loads and to collect the energy of DC sources.
- Development of project management tools and methods.
- Demonstration of increased energy efficiency measures such as, for example the use of variable-speed motors, led lighting, storage systems, etc.
- Investigations to enable selectivity between circuit protection devices using different technologies, such as semiconductor breakers, hybrid semiconductor breakers, mechanical breakers and fuses.
- Systems grounding to avoid stray currents and corrosion phenomenon from DC systems such as e.g., rail applications.
- Insulation materials and their applicability for DC loads (investigation on suitability of AC cables for DC, on polarisation effects leading to early degradation and subsequent insulation failure, etc.).

D. Application of DC distribution in ports

- Simulation, analysis, design, develop, test and demonstration of a DC port infrastructure. Feasibility of Medium Voltage Direct Current (MVDC) distribution network to supply the DC powered ports as well as to supply other DC loads and to collect the energy of DC sources.
- Study and development of a tool to estimate the quantity of DC charging infrastructure necessary to support regional adoption of ports' electrification by MS.
- CBA at system level of a DC compared to an AC supplied port considering all the elements contributing to a real effective analysis on the costs and benefits of the system.
- Simulation, analysis, design, test and demonstration of all the IT needed for the grid automation.
- Analysis and definition of possible operating framework and business models for ports acting as energy hubs.
- Analysis, report and recommendations on the potential of the ports as energy hubs with related planning for its development within the energy transition.

2. Demonstration, test and validation of at least two of the sub-topics developed in (1) (A, B, C or D) in at least two pilots in different EU Member States/Associated Countries.

3. Identification of standardisation, regulatory barriers and related recommendations.

HORIZON-CL5-2023-D3-01-12: Development of MVDC, HVDC and High-Power Transmission systems and components for a resilient grid

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
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 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. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [164].

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

- Investigation and development of new converter systems (including back-to-back, floating, new systems with improved compatibility, lower losses, for superconducting technologies applications i.e., medium voltage, high current, etc.) for higher efficiencies.
- Investigation and development of additional sustainable energy storage solutions, interfacing with MVDC, HVDC and/or High-Power Transmission systems, to support

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

the AC system. Storage solutions should aim at high round-trip efficiency, low dependence on critical raw materials, low land/space footprint.

- Investigation and development of DC breaker integrated in Multi-terminal DC (MTDC) systems, including DC breaker for integration with Superconducting cables.
- Investigation and development of the application of DC GIS in VSC MVDC, HVDC converters, including economic benefits on overall system solution.
- Investigation and development of SF6-free technology for new equipment in substations.

Scope: Projects are expected to implement the activities in (1) or in (2) and the corresponding practical demonstration in (3) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to the topic:

- Development of smaller, more compact and/or lower voltage, higher current converter topologies, including floating that can result in significant cost savings offshore.
- Technical analysis of trade-offs in performance, ambient condition impact, maintenance, reliability, dimensioning, testing procedures, etc.
- Demonstration of enhancement of AC system stability and AC system frequency by providing sustainable energy storage systems interfaced to MVDC, HVDC and/or High Power Transmission systems.
- Assessment of technical and economic feasibility of application of DC breakers in MTDC systems.
- Demonstration of DC fault ride through capabilities in MTDC systems by using DC breakers.
- Assessment of potential new converter topologies addressing future offshore developments with the aim of reducing the CAPEX and OPEX of the investments, and with increased fault current capabilities.

2. Boost SF6-free technologies in high and medium voltage equipment, as well as a regulatory roadmap for replacement and new assets (HV: TRL 4-5; MV: TRL 6-8):

- Investigation and development of switchgears using SF6-free technology with low impact on GWP. Alternative SF6 gases with low environmental impact while at the same time ensuring low space occupancy for offshore applications on platforms.
- Assessment of grid resilience and the economic and environmental impact of replacement and new installation rollout options (timeline, perspective of global market, grid reliability and full lifecycle impact).

- Regulatory recommendations at EU level to cope with financial risks inherent with putting novel technologies into the system and transition time options to move from SF6 to SF6-free technology for new equipment.

- Investigation and development of an SF6-free gas-insulated substation or air-insulated SF6-free instrument transformers or switchgear at different voltage levels.

3. Demonstration, test and validation of the activities developed in (1) or in (2) in at least two pilots in different EU Member States/Associated Countries.

The selected projects are expected to contribute to the BRIDGE initiative [165], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-13: Development of novel long-term electricity storage technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
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: Project results are expected to contribute to all the following expected outcomes:

[165] https://www.h2020-bridge.eu/

- Increased availability, robustness, and safety of sustainable and efficient energy storage solutions to reduce energy losses, increase cost effectiveness and improve the environmental footprint of the energy system.
- Availability and functionality of innovative energy storage systems developed for specific system designs and applications.
- Increase technology leadership, competitiveness, and technology export potential of European storage technology industry.
- Enhanced sustainability of storage technologies, taking fully into account circular economy, social, economic, and environmental aspects in line with the European Green Deal priorities.

Scope: Development of novel storage technologies, going beyond the state of the art, which are providing best-fit in form of CAPEX, OPEX, efficiency and sustainability and are adapted to specific needs of the energy system. Examples for such specific needs are responsiveness to energy system flexibility need, necessary storage amount or specific requirements due to off-grid situations. Focus is on longer-duration technologies, compared to lithium-ion technology, which is currently dominating new storage projects. In scope are novel chemical, mechanical, thermic storage technology solutions, excluding batteries and hydrogen. Innovative storage solutions should show clear innovation with respect to the state of the art e.g. through use of new advanced materials or new design solutions, always bearing in mind the objective of sustainability and circular economy, minimizing the environmental footprint, which should be underpinned by an LCA. The developed solutions should be highly performant in respect of expected future investment and operational costs and business cases in existing or emerging energy markets and go beyond the state-of-the art of existing storage solutions in respect of two or more of the following parameters:

- Sustainability;
- Technical performance, including round-trip efficiency;
- Lifetime;
- Non-dependency on location geographical particularities strategic independence (=no or limited use of CRMs);
- Land (space) footprint and/or cost.

Underlying basic material research is excluded.

Projects should address to the extent appropriate intelligent energy management systems, economic viability studies validated by industry and assessment of large-scale replication potential.

The selected projects are expected to contribute to the BRIDGE initiative[166], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-14: Demonstration of innovative, large-scale, seasonal heat and/or cooling storage technologies for decarbonisation and security of supply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Increased availability, robustness and safety of sustainable and efficient choices for energy storage to increase security of supply, reduce energy losses, cost effectiveness and improve the environmental footprint of the energy system.
- Availability and functionality of innovative large-scale energy storage systems developed for specific system designs and applications.
- Increase technology leadership, competitiveness and technology export potential of European storage technology industry.

166 https://www.h2020-bridge.eu/

- Enhanced sustainability of storage technologies, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

- In addition to development of the storage technology as such, it should be made suitable to accumulation of different heat sources, including solar-thermal energy, geothermal energy, industrial waste heat, as well as heat produced using photovoltaics, hybrid solar panels (Photo-Voltaic Thermal Panels) and wind energy technologies.

- Systemic approach, smart integration concepts, including intelligent management together with other energy sources. Efficient techniques/methodology of buffering between demand and supply to be ensured.

Scope: Demonstration of innovative heat and/or cooling storage technologies, going beyond the state of the art, which address long-term energy storage up to cross-seasonal storage. Large-scale solutions are expected to be embedded into

- District-level heating and/or cooling storage.

- and/or integrate heat supply (industry waste heat) and demand for heat for industrial processes.

Where appropriate, contribution to Power-to-Heat-to-Power technology should be explored.

They should optimise CAPEX, OPEX and round-trip efficiency of heat storage, as well as circularity and sustainability of the system and its components, which are expected to be non-toxic, highly durable and reasonably easy to recycle. Land (space) footprint is also an important aspect which should be taken into account. An LCA should be performed. Strategic independence is to be considered, i.e. use of abundant materials whenever it is possible.

The demonstration projects should address the required methodologies for the predictive maintenance and control of the whole system.

Maximum use of all available thermal energy sources as well as systemic approach to integration into energy system is to be ensured.

(Indirect) collaboration with IEA's Energy Storage Technology Collaboration Programme is to be ensured, e.g. through IEA Member States. Notably: Task 39 "Large Thermal Energy Storages for District Heating".

Basic material research is excluded.

Projects should address economic viability studies validated by industry and assessment of large-scale replication potential. The exploitation plans should include business plan indicating the possible funding sources to be potentially used (such as private equity, InvestEU, EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2023-D3-01-15: Supporting the green and digital transformation of the energy ecosystem and enhancing its resilience through the development and piloting of AI-IoT Edge-cloud and platform solutions

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
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 for digital energy solutions by the end of the project starting from general purpose digital solutions of at least TRL 5-6 – see General Annex B.

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

- Major contribution to the implementation of the Digitalisation of Energy Action plan.
- Innovation in data-driven energy services by 3rd parties through fast spreading, market uptake and validation under critical operating conditions in a real environment of transparent, accessible and reliable highly distributed open platforms, frameworks and mechanisms for data exchange and storage to support innovative services (for flexibility, RES integration, etc.) across the EU, based on Open Source developed solutions.
- Validation in a large-scale environment of the application of cutting-edge digital technology (Cloud-Edge continuum, edge intelligence, AI/ML (federated learning), IoT) in a more decentralised environment in the energy sector.
- Full set of relevant commonly agreed digital standards applicable to the energy sector through extension and update of existing standards and new standards filling standardisation gaps.

Scope:

- The action should develop solutions that aim at increasing the integration of renewable energy sources, as well as the local generation and consumption of energy and processing of data by developing and piloting at scale open source, environmentally friendly, easily upgradeable and energy-efficient cloud-edge solutions. The application space should include but is not limited to bi-directional EV charging, smart buildings and homes. Solutions are expected to be based on commonly agreed open standards. To the greatest extent possible, they should be building on the common European cloud-edge infrastructure as well as making use of and contributing to the emerging common European data spaces in the fields of energy and mobility. Further, they should support a more decentralised environment for grid flexibility and energy services, based on digital enablers such as artificial intelligence, swarm computing and IoT.

- Validation should be done at least three pilot sites in at least three Member States/Associated Countries and could include under "financial support to third parties" an open call for additional services using up to 10% of the total budget to attract further users and suppliers, in particular SMEs. The modalities of the open call will be defined by the consortium, based on the concrete needs of the project. The appropriate level of data localisation and processing (cloud, edge, far edge, etc.) should be defined on-the-fly by AI algorithms to optimise latency, energy consumption, security, and other important parameters. The solutions must demonstrate critical operation capability such as low-battery, fault tolerance, and harsh weather conditions to ensure the resilient operation.

- To ensure the interoperability among the solutions and with other European IoT research and innovation efforts in the energy and other sectors and the integration into the grid, the project will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing EU programmes and other relevant initiatives[167]. Preferably semantically interoperable interactions, as enabled by the ETSI SAREF ontologies, should be used. The projects will be expected to contribute to the piloting, uptake and further development of relevant standards.

- Solutions should include a credible market uptake plan of developed solutions across the EU, in as diverse types of regions and electricity grids (in terms of climate, size, economic activities), and enable 3rd parties, in particular SMEs, to use the developed solutions as a basis to build their innovative data-driven energy services innovations for energy consumers on top of the developed solution. These solutions should collaborate where relevant with the Testing and Experimentation Facility (TEF) for the energy sector.

- The selected projects are expected to contribute to the BRIDGE initiative[168], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional

[167] For example, Horizon 2020, Horizon Europe, Digital Europe Program and Connecting Europe Facility, the Data Space design principles of Open DEI, the project supported under the Interoperability Community CSA and aligned with the Digital Europe Data Centre Support Centre, etc.

[168] https://www.h2020-bridge.eu/

contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2023-D3-01-16: Support action to the SET Plan IWG on HVDC & DC Technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 0.60 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 0.60 million.
Type of Action	Coordination and Support 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).

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

- Organisational, logistic and secretarial support provided to the SET Plan Implementation Working Group on HVDC.
- Smooth implementation through supporting the actions of the SET Plan for HVDC and DC Technologies in the coming years for the offshore as well as onshore grid development.

Scope: The Implementation Working Group (IWG) on HVDC was set up in 2021 to address specifically the grid development needs deriving from a renewable-based energy system, as called by the Green Deal. With the perspective of the installation of 60 GW of offshore wind and at least 1 GW of ocean energy by 2030 (300 GW and 40 GW by 2050), the Offshore Renewable Energy Strategy has been the triggering event for the creation of the WG. The activities of the IWG range from the support to the development of DC Technologies and Systems to the fostering of the collaboration and coordination within the SET Plan countries to ensure their active involvement.

The support action is intended to facilitate the work of the IWG by providing support to the Implementation Plan on HVDC with activities focusing on:

- Organisational support to the Implementation Working Group on HVDC.
- Coordination with other initiatives/projects and links with stakeholder's fora.
- Dissemination and networking activities with other existing ETIPs and IWGs (e.g., joint workshops, thematic conferences, webinar series, regular exchanges, etc.).
- Development and implementation of robust outreach approaches and societal engagement actions to span across the EU and Associated Countries**.**
- Organisation and management of documents and files with feed-in of relevant outputs of this CSA into the SET Plan information system (SETIS).

Carbon Capture, Utilization and Storage (CCUS)

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-01-17: Development of CO2 transport and storage demo projects

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
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 demo project is expected to use the CO2 from one or more capture sites and build or use a transport infrastructure, incl. shipping if needed, to the selected storage site where the CO2 will be injected. Practical experience with a demo project of that kind will increase the knowledge of the full CCS value chain including risk mitigation (financial, technical, and regulatory) taking into account the experience and results from previous research projects. Beside others this might include

for CO2 transport:

- impact of CO2 origin, composition and impurities
- safety assessments and engineering design tools
- transport of CO2 interoperability, including ships
- reuse of pipelines, wells and platforms
- hubs and clusters and concepts
- environmental impacts and risks
- CO2 flow assurance

for CO2 storage:

- preparation of storage sites (depleted oil and gas reservoirs, saline aquifers, basalt rocks)
- develop experience with site conformance monitoring and assessment
- storage optimisation through development of a range of injection strategies
- improve understanding of induced seismicity
- prediction of plume under geophysical and geological uncertainty
- flexibility of CO2 injection ramp up
- environmental impacts and risks, including in the long term

The demo project is expected to be the basis and orientation for future full-size projects.

Scope: The development of regional CCUS clusters and their connection to European CO2 transport and storage infrastructures that enables cross-border cooperation across regions is crucial for reaching net-zero GHG emissions by 2050. The CCUS technology is not sufficiently operational in Europe yet. To overcome the remaining challenges, further R&I of CO2 transport and storage demo projects is needed.

Proposals will aim at the development of new demonstration projects connecting CO2 sources with potential storage sites. Proposals are expected to include a sound assessment of their environmental challenges and risks and feasibility studies focusing on the possible synergies between related projects.

CCUS is an integrated chain of technologies, comprising capture, transportation and/or use and geological storage of CO2. The next step in the application of CCUS is the development and deployment of CO2 transport and storage demo projects which show the practical feasibility of the required technologies. This is important to achieve greater efficiency in the transportation of CO2, notably collecting the emissions from hubs and clusters of industrial

facilities and transporting the collective CO2 in shared open-access transportation infrastructure to a storage location. Under this approach, costs, risks and necessary support mechanisms can be better evaluated across the CCS value chain, as industrial installations, gas infrastructure companies and storage providers and operators will have clearly defined roles and responsibilities for delivering their tasks and will be compensated for collecting, transport and storage services. The benefits of the shared approach to the transport and storage infrastructure are expected to be evaluated with regard to economies of scale and possibly driving down unit costs for the CCUS value chain. The proposal should address possible barriers for deployment of technical or regulatory nature.

The key options for CO2 transportation are pipeline transport using new or repurposed infrastructure incl. shipping or other transport modes. The expected demo projects should

- assess the repurposing of existing pipeline networks and/or the creation of new CO2 transport infrastructure,
- identify and evaluate the benefits and costs (including economic, environmental, social),
- identify barriers to developing such an infrastructure and what action would be required to overcome these.

A successful CO2 transport and storage demo project might require a European transport and storage network with cross-border connections as not all countries have sufficient storage capacity for their CO2 emissions.

The selection of the storage site for the project is expected to be based on a detailed assessment. This should include a geological characterisation, including faults and facture systems; analysis of initial stress field and geo-mechanical behaviour of the storage formations and seals under varying stress and pore-pressure conditions; estimation of storage capacity; accurate modelling of injectivity; overall storage risk assessment, including induced seismicity and blow-out or blockage during injection, and including proposed mitigation action. The assessment should include site-specific solutions for CO2 injection strategies, pressure management, mitigation of induced seismicity, and MMV (measurement, monitoring and verification).

For CO2 transport and geological storage, in particular onshore, public acceptability is paramount. Therefore, projects are expected to identify and engage relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) in deliberative activities, so as to analyse their concerns and needs using appropriate techniques and methods from the social sciences and humanities. This should include attention to, significant differences in potential regional consequences where the CO2 stored comes from power versus industry. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities.

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

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Projects are strongly encouraged to join the EU CCUS knowledge sharing project network.

HORIZON-CL5-2023-D3-01-18: Clean Energy Transition Co-funded Partnership

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 71.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 71.00 million.
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 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 of 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 in WP 2023-2024.

The second instalment of the partnership is expected to contribute to expected outcomes specified in topic HORIZON-CL5-2021-D3-01-04: Clean Energy Transition, for continuation and new development of activities.

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

- Increased directionality of clean energy transition research and innovation in Europe in line with the SET Plan by a shared pan-European vision regarding the goal and direction of the required system transformation processes adapted to regional needs and availability of renewable energy resources.
- Evidence based energy and climate policy formulation.

- A wider systemic transition and energy supply required for the climate transition in all sectors of society; enabling the transition of the built environment, transport, industry and other sectors to clean, low carbon energy.

- An innovation ecosystem for Europe's transition to clean energy and contribute to a resource-efficient energy system, both from an ecological and economic standpoint.

- A building block to a zero-emission energy system for the decarbonisation of transport, buildings, industry, agriculture in the specific European environment.

- Increased engagement of consumers and prosumers and in appropriate demand-response mechanisms and its integration in the energy system.

- And finally, an energy system that meets the needs of different parts of society, in different geographical locations (urban and rural) and different groups.

Scope: The Clean Energy Transition co-funded Partnership (CET Partnership) is a transnational initiative on joint R&I programming to boost and accelerate the energy transition, building upon regional and national R&I funding programmes.

It aims at empowering the energy transition and contribute to the EU's goal of becoming the first climate-neutral continent by 2050, by pooling national and regional R&I funding for a broad variety of technologies and system solutions required to make the transition. It will foster transnational innovation ecosystems from the very local and regional level, up to the transnational European level, thus overcoming a fragmented European landscape. The CET Partnership enables national and regional R&I programme owners and managers from Member States and Associated Countries to align their priorities and implement annual joint calls from 2022 to 2027. They also organise joint accompanying activities to enable a dynamic learning process, extract strategic knowledge and maximise the impact to accelerate the upscaling, replication and market diffusion of innovative solutions. This will foster the up-take of cost-effective clean energy technologies.

The common vision of the CET Partnership is already manifested in its Strategic Research and Innovation Agenda (SRIA) that has been co-created with the involved countries, the EU SET Plan Implementation Working Groups and ETIPs, all energy relevant ERA-Nets as well as the EERA joint programmes (over 500 editors, co-authors, commenters and discussants). The SRIA articulates the common goal of (1) building a transnational transformative Joint Programming Platform, (2) developing and demonstrating technology and solutions for the transition of energy systems, and finally (3) building innovation ecosystems that support capacity building at all levels.

The objective of this action is to continue to provide support to the European Clean Energy Transition Co-fund Partnership identified in the Horizon Europe Strategic Plan 2021-2024 and first implemented under the topic HORIZON-CL5-2021-D3-01-04, and in particular to fund additional activities (which may also be undertaken by additional partners) in view of its

intended scope and duration, and in accordance with Article 24(2) of the Horizon Europe Regulation.

The consortium which applied to and received funding under HORIZON-CL5-2021-D3-01-04 is uniquely placed to submit a proposal to continue the envisioned partnership. Not only did this consortium submit the proposal leading to the identification of the partnership in the Horizon Europe strategic planning 2021-2024, it has also implemented the partnership through a co-funded call in 2022 and a second call is planned for 2023 in line with the HORIZON-CL5-2021-D3-01-04 Clean Energy Transition topic. It is also relevant that the same consortium was responsible for carrying out related co-fund actions in the field of clean energy under the Horizon 2020 predecessor programme. In this context, the current consortium has particular expertise in relation to the objectives of the Partnership, to the activities to be implemented, and to other relevant aspects of the co-fund action. In practice, another consortium could not continue the activities of the Partnership underway without significant disruption to the ongoing activities, if at all.

The new geopolitical and energy market realities require to drastically accelerate the clean energy transition and increase energy independence from unreliable suppliers and volatile fossil fuels. In support to the objectives of REPowerEU[169] it is expected that the partnership explores pathways and develop new actions to reinforce R&I investments accelerating the clean energy transition and to reinforce the utilisation of R&I results.

It is expected that the European Clean Energy Transition Co-fund Partnership considers also to reinforce the ambition of the planned 2023 joint call and will continue the implementation of its SRIA by setting up joint calls in 2024 and 2025. The partnership can consider to set-up also joint calls without co-funding of from the Union.

Taking into account that the present action is a continuation of the topic HORIZON-CL5-2021-D3-01-04 and foresees an amendment to an existing grant agreement, the proposal should also present in a separate document the additional activities (which may include additional partners) to be covered by the award in terms of how they would be reflected in the grant agreement.

While the award of a grant to continue the Partnership in accordance with this call should be based on a proposal submitted by the coordinator of the consortium funded under the topic HORIZON-CL5-2021-D3-01-04 and the additional activities (which may include additional partners) to be funded by the grant should be subject to an evaluation, this evaluation should take into account the existing context and the scope of the initial evaluation as relevant, and related obligations enshrined in the grant agreement.

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

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Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-02

Conditions for the Call

Indicative budget(s)[170]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[171]	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 05 Sep 2023				
HORIZON-CL5-2023-D3-02-01	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-02	RIA	5.00	Around 2.50	2
HORIZON-CL5-2023-D3-02-03	IA	6.00	Around 3.00	2
HORIZON-CL5-2023-D3-02-04	RIA	6.00	Around 2.00	3
HORIZON-CL5-2023-D3-02-05	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-06	IA	15.00	Around 5.00	3
HORIZON-CL5-2023-D3-02-07	RIA	12.00	Around 4.00	3
HORIZON-CL5-2023-D3-02-08	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-09	IA	8.00	Around 8.00	1
HORIZON-CL5-2023-D3-02-10	RIA	8.00	Around 4.00	2
HORIZON-CL5-2023-D3-02-11	RIA	9.00	Around 3.00	3
HORIZON-CL5-2023-D3-02-12	IA	14.00	Around 7.00	2

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

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

HORIZON-CL5-2023-D3-02-13	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D3-02-14	RIA	12.00	Around 6.00	2
HORIZON-CL5-2023-D3-02-15	RIA	12.00	Around 4.00	3
HORIZON-CL5-2023-D3-02-16	IA	20.00	Around 5.00	4
Overall indicative budget		161.00		

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

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-02-01: Development of near zero-emission biomass heat and/or CHP including carbon capture

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Advance the European scientific basis and increase technology competitiveness and technology export potential in the area of bioenergy.
- Reduced cost and improved technical performance and efficiency of bio-based heat and/or CHP.
- Enhance sustainability of biomass-based heat and/or CHP by addressing socioeconomic and environmental sustainability, in particular in reducing emissions and air pollution and also addressing aspects of carbon reuse and circularity, also in particular in fossil-fuel-based economic areas in transition.

Scope: Development of novel near zero-emission bio-based heat and/or CHP technologies, which allow for highly efficient use of sustainable solid biomass residues, going hand in hand with close to zero emissions for particles and harmful gaseous emissions including NOx, SOx, aromatics etc. Flexibility for different biomass fuels and power/heat ratios featuring a wide range of temperatures for heat supply as well as technological interfaces for carbon capture as well as high cost-efficiency for the consumer are to be included.

The near zero-emission solution has to be implemented and assessed for the running biomass-based heat and/or CHP system at pilot scale. Cost performance and environmental impact should be assessed and improved in comparison to state-of-the-art emissions capture and cleaning systems.

Socio-economic aspects including SDGs when applying such solutions in regions in transition from coal, lignite, peat, or other fossil fuels should be analysed and illustrated in the proposal.

HORIZON-CL5-2023-D3-02-02: Novel thermal energy storage for CSP

Specific conditions

Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Improved dispatchability of concentrated solar power (CSP) plants.
- Improved role of CSP plants in the energy system.
- Reduced greenhouse gas emissions.
- Achievement of the CSP targets of the Strategic Energy Technology Plan.

Scope: Support will be given to novel thermal energy storage solutions for CSP plants. The thermal energy storage solutions proposed will have to be more efficient, cost effective and reliable than current commercial solutions and achieve similar performance in terms of cycles.

The applicants should convincingly present that the storage solution that is developed has the potential to be applied at commercial level.

Projects should consider the possible impact on human health and assess the sustainability of the proposed solutions in environmental and socio-economic terms, taking into consideration the global value chains. Applicants are encouraged to consider a ‘circularity by design’ approach.

HORIZON-CL5-2023-D3-02-03: Industrial manufacturing for lower-cost solar thermal components and systems

Specific conditions	
Expected EU	The Commission estimates that an EU contribution of around EUR 3.00

contribution per project	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Reduced greenhouse gas emissions.
- Reduced consumption of materials.
- Reduced environmental footprint of the European solar thermal manufacturing industry.
- Increased competitiveness of the European solar thermal manufacturing industry.

Scope: Support will be given to innovative solutions to manufacture components and/or sub-systems and/or systems for solar thermal applications. The manufacturing solutions should increase the production output and reduce the cost vis-à-vis current production lines. The solutions should integrate quality controls and be flexible enough to adapt to various solar thermal applications.

The proposal should assess and optimize the requirements in terms of materials needed to produce the components and/or sub-systems and/or systems.

Applicants are encouraged to consider a ‘circularity by design’ approach.

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

HORIZON-CL5-2023-D3-02-04: Innovative components and configurations for heat pumps

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
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: Project results are expected to contribute to some of the following expected outcomes:

- Improved performance of heat pumps and/or heat pump components.
- Reduced environmental footprint of heat pumps and/or heat pump components.
- Reduced greenhouse gas emissions.
- Enhanced energy system integration.

Scope: Support will be given to develop innovative heat pumps and/or heat pump components. The innovative heat pumps and/or heat pump components should be more efficient and more reliable than current commercial solutions. They should be safe and affordable.

The proposal should assess and optimize the requirements in terms of materials needed to produce the heat pumps and/or heat pump components.

Applicants should apply a ‘circularity by design’ approach and assess the sustainability of the proposed solutions from a life cycle perspective. Among others, they should estimate the carbon footprint expressed in $gCO2_e$/kWh of heat and/or cold delivered.

The requirements of the final users and/or installers should be properly assessed (e.g., in terms of 'plug-and-play' installation, day-to-day operation, maintenance, space requirements, noise, integration with networks and/or other devices, demand response capability, etc.).

Proposals investigating heat pumps with a capacity >12 kW are expected to use refrigerants with 100-year Global Warming Potential (GWP) < 150 (timeframe based on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)).

Proposals should consider standardisation activities as part of their R&I approach, with a view to bringing their technologies closer to the market.

HORIZON-CL5-2023-D3-02-05: Advanced exploration technologies for geothermal resources in a wide range of geological settings

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Reduction of LCOE approaching SET Plan targets.
- Improved exploration technologies leading to increased drilling success rate and performance and reliability improvement of shallow and/or deep geothermal systems.
- Increased knowledge to reduce risk of seismicity and to reduce environmental impact in line with the DNSH principle.
- Increased region, city, and citizen engagement for geothermal energy.

Scope: To ensure a reliable pre-drilling assessment of shallow and/or deep geothermal resources and reservoirs, high resolution reservoir characterisation and exploration methods and approaches are essential to minimize exploration and production risks.

The projects will have to include:

1. The development and application of new tools and techniques for a wider range of geologically complex geothermal resources/reservoirs and
2. Coupled with innovative modelling and simulation techniques, increasing measurement precision and applying faster analysis of acquired data to achieve a feasible model of the reservoirs, and fracture systems and
3. The update and improvement of state-of-the-art geological reservoir characterisation and exploration techniques and methods to reduce the average cost for exploration. Such progress will be addressed in increasing detail the geological complexity of resources and increasing target depths.

Technical and economic validation is expected of the innovative exploration and production approaches and tools and methods which are expected to increase the precision for geologically based resource assessment, the target definition of exploratory drilling, and to improve the characterisation and prediction of reservoir geology and long-term reservoir performance. Moving beyond the state of the art by demonstrating the application of new tools, developing new approaches and taking advantage of improved software and computing power, the drilling success will be increased by 20% in 2030 and 50% in 2035 thereby reducing the exploration costs.

HORIZON-CL5-2023-D3-02-06: Smart use of geothermal electricity and heating and cooling in the energy system

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
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: Geothermal as backbone of a heating grid including geological thermal storage facilities as system support. Project results are expected to contribute to all of the following expected outcomes:

- Geothermal energy will be widely deployed and competitively priced, underpinned with reduced capital, operational and maintenance costs. Geothermal and geological thermal storage facilities as support system will be a backbone of the heating grid .
- Improved system integration of geothermal heat and power plants coping with changing demand for electricity, heat and cooling and intermittent renewable power generation.
- Enhanced operation flexibility of a geothermal heat and power plant by improving substantially key performance indicators: ramp rate & start-up time, power & heat operation range, overload capability.
- Implementation of smart control system aiming at optimizing plant operation by taking into account various control parameters (current and anticipated) such as demand (power & heat), price signals, flexibility of demand, ancillary grid services, renewable generation, etc.

Scope: Projects are expected to:

- Demonstrate the technical and economic feasibility of responding to commands from a grid or network operator, at any time, to increase or decrease output ramp up and down. - demonstrate the automatic generation control (load following / ride-through capabilities to grid specifications) and ancillary services of geothermal power plants Address flexible heating and/or cooling supplied from binary cycles or EGS plants, including coupling with renewable energy sources.
- Increase variable demand of heating, cooling and electricity by integration of adequate installations and equipment such as heat pumps, energy piles, energy sheet pile walls, ORC turbo-expanders, heat exchanger networks, hot and cold reservoirs (e.g. geothermal storage, UTES).

Actions are expected to consider the development of transmission and distribution infrastructure, and the interplay with other flexibility options (e.g. demand-side management and storage), and test on dispatchability leading to AI-based smart thermal grids balancing generation and demand. The flexible generation should be able to provide additional services to the grid such as inertial services/peak power, role in electricity balancing/reserve market. Projects should integrate increased diagnostics on components for performance/reliability monitoring (maintaining high level of heat transfer – durability, fouling issues…).

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

introduction to this Destination. The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2023-D3-02-07: Development of next generation advanced biofuel technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Increase availability of disruptive emerging advanced biofuel technologies.
- Accelerate the readiness of cost-effective and highly performing future technologies of advanced biofuels for all economy sectors.
- Reinforce the European scientific basis and European technology export potential for advanced biofuel technologies.

Scope: Development of next generation technologies for the production of novel advanced liquid and gaseous biofuels from biogenic residues and wastes including CO2 and organic part of wastewater or micro-algae (including cyanobacteria), through chemical, electrochemical, biochemical, biological and thermochemical pathways, or a combination of them. Focus should be on the high conversion efficiency and the low to near-zero carbon emissions from the overall production. Overall, proposals are expected to improve competitiveness and minimize GHG emissions through synergies with renewable hydrogen

and other renewable energy technologies for processing energy. The new technologies should also address specifically uses in fuel cells for all transport modes for electricity generation from biofuels used as renewable energy carriers with high conversion efficiency and low pollution. The sustainability and GHG emissions should be assessed by an LCA and ways along the value chain to reduce them to and below net zero should be developed.

HORIZON-CL5-2023-D3-02-08: Development of microalgae and/or direct solar fuel production and purification technologies for advanced aviation and /or shipping fuels

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to at least 3 of the following expected outcomes:

- Availability of disruptive sustainable renewable fuel technologies in order to accelerate the replacement of fossil-based energy technologies in aviation and/or shipping.
- Reduced cost and improved efficiency of sustainable microalgae-based and/or direct solar renewable fuel technologies and their value chains.
- Increase technology leadership, competitiveness and technology export potential of European industry in possibly game-changing microalgae and/or direct solar renewable fuel technologies.
- Enhanced sustainability of aviation and/or shipping fuels, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).

- Increasing the European energy security and reliability by enlarging the renewable feedstock basis for aviation and maritime fuels as well as maintaining and fostering the European global leadership in affordable, secure and sustainable microalgae-based and/or direct solar fuel renewable energy technologies.

Scope: Development of microalgae and/or direct solar fuel production and purification technologies for making advanced aviation and /or shipping fuels from microalgae and/or direct sun use a techno-economic feasible, cost-effective and sustainable option for large-scale use of microalgae-based and/or solar-based advanced fuels in aviation and /or shipping. Specific focus should be on purification of microalgae biomass and /or direct solar fuel components and delivery to advanced algae-based fuels and /or direct solar fuels for aviation and/or shipping. Acknowledging problems of culture or system contamination and the specific challenge of energy-efficient product purification, the specific techno-economic challenges of microalgae and/or direct solar fuels for renewable fuel production should be addressed with novel and innovative technologies, by taking in particular into account effects on CAPEX, OPEX, energy efficiency, GHG balance and circularity of materials and process streams. Proposals should also address systemic constraints and opportunities for scaling-up algae-based and/or solar fuel technologies.

Direct solar fuels are in this context renewable synthetic fuels made by direct conversion routes from solar to chemical energy. Photovoltaic systems with separate fuel production and hydrogen as a fuel end-product is excluded.

The sustainability and GHG reduction should be addressed on a life-cycle assessment basis including circular economy, social, economic and environmental aspects.

Projects are expected where possible to collaborate with and contribute to the activities of the Coordination and Support Action funded under the topic HORIZON-CL4-2021-RESILIENCE-01-16

HORIZON-CL5-2023-D3-02-09: Demonstration of sustainable hydropower refurbishment

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.

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.
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). [172].

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

- Refurbish, upgrade and increase existing hydropower capacity to make it fit for market and digital challenges of the future power system and for supporting increasing shares of variable renewable energy sources.
- Increase technology leadership, competitiveness and technology export potential of European hydropower industry.
- Enhanced sustainability of refurbished hydropower installations, taking fully into account circular economy, social, economic and environmental (including climate change) aspects in line with the European Green Deal priorities and in particular biodiversity.

Scope: Demonstration of innovative solutions for sustainable hydropower refurbishment. With existing hydropower installation as a base, solutions are expected to demonstrate innovative technical solutions for refurbishment with increased sustainability of refurbished hydropower in terms of business models in changing power markets, including digital requirements. In this context, the overall future potential of the innovative solutions in EU Member States/Associated countries should be analysed. It is required to improve

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

environmental sustainability with a particular focus on biodiversity including up- and downstream -migration of aquatic organisms and sediment management and maintaining important geomorphological processes and preserving habitats. Also, additional benefits for society should be addressed, e.g. for recreational use, flood control, navigation, drought management. The innovative refurbishment solution should go beyond increased efficiency but lead to net-improvements in socioeconomic and environmental sustainability also considering future climate change adaptation needs. Socio-economic and environmental sustainability including SDGs, circular economy, social, economic and environmental aspects should be addressed on a life cycle basis.

HORIZON-CL5-2023-D3-02-10: Development of innovative power take-off and control systems for wave energy devices

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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.
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). [173].

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

- Demonstrated increased performance and reliability of wave energy devices.
- Improved knowledge on how to operate wave energy devices, their availability, maintainability and survivability.
- Reduction of LCOE.
- Reinforced industrial supply chain in Europe.

Scope: Power take-off (PTO) and control systems (including "prime mover" (waves to mechanical power) as well as the ancillary equipment like gearboxes, generators, and power electronics, power controllers, grid interfaces and other items) are key subsystems of wave energy converters. PTO and control systems can be improved to increase the efficiency of the whole converter, to increase reliability by controlling for instance the structuring health and power electronics, and to avoid extreme events that might compromise device survivability. Control systems dynamically adapt to and mitigate the forces of the continually changing ocean conditions. This can prevent damage during extreme events, contribute to increased performance and the viability of the technology. The manufacturing and testing of prototypes are relatively costly, and it is imperative that data from the demonstration are available to avoid repeating early engineering mistakes. Validation of the innovative concepts is expected to be done in realistic environments at small scale for longer periods or by onshore testing and controlled lab testing. If validation is done onshore the project should demonstrate that they can make use of existing test rigs or develop a test rig for the project, which can be used after the project by other developers. Development and demonstration of the PTO technology should be combined with control strategies as their requirements are inherently coupled. In the validation it is expected that key performance indicators are used based on international recognized metrics

In the development of the PTO system the ‘circularity by design’ principle should be used.

HORIZON-CL5-2023-D3-02-11: Advanced concepts for crystalline Silicon technology

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Research and Innovation Actions
Eligibility	The conditions are described in General Annex B. The following

conditions	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: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements.

Consequently, project results are expected to contribute to all of the following outcomes:

- PV modules with higher efficiencies and lower costs, paving the way for mass production.
- Lower environmental impact with efficient and optimised use of materials/resources.

Scope: Wafer-based crystalline silicon (c-Si) PV technology is dominating the PV market, sharing its 95%, with a significant historical module price reduction trend. The driving force for such PV cost reduction is undoubtedly attributed to the advancement in cell and module performance in the last few decades, in addition to economies of scale. Improving cell and module efficiency will continue to play a significant role in lowering the levelized cost of electricity (LCOE), by saving the cost of land and balance of systems while producing the same amount of electricity.

Proposals are expected to develop architectures approaching the theoretical efficiency limit of c-Si cells and providing the direction for even higher mass-production industrial cell performance (for example by reducing surface recombination in silicon, lowering recombination losses at metal contacts, maximizing light trapping in silicon, etc.), with:

1. Nanophotonic structures to maximize absorption and minimise reflection, enabling reduced silicon consumption and higher efficiencies.
2. Innovative texturisation and light-trapping concepts for thin and ultrathin c-Si solar cells.
3. Advanced low-cost surface passivation and novel passivating contacts; novel heterojunctions.
4. Low-cost and Ag-free metallisation, TCOs using abundant materials (In-free), such as AZO.
5. Direct bandgap architectures for very high efficiencies and/or thinner cells.

HORIZON-CL5-2023-D3-02-12: Large Area Perovskite solar cells and modules

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements.

Consequently, project results are expected to contribute to all of the following outcomes:

- Increase the lifetime, efficiency and minimise the environmental impact of Perovskite PV.
- Enlarge with novel perovskite device architectures the integration and application possibilities of PV technology.
- Increase the potential for industrial production and commercialisation of perovskite PV creating a competitive technological know-how for the European PV industrial base.

Scope: The record power conversion efficiency of small-area perovskite solar cells has impressively exceeded 25%. For commercial application, scaling up the device area to fabricate efficient perovskite solar modules is the necessary next step. However, there is still a certain efficiency gap between the large and small size. To minimise this gap proposals are expected to:

- Demonstrate an industrially scalable method for the (homogeneous) deposition of high-quality large-area perovskite films.
- Demonstrate fabrication of large-area charge transporting layers and electrodes.

In addition to improving the efficiency for commercial development of Perovskite PV, lifetime is another challenge that urgently needs to be addressed also in tandem architectures.

- Identify and tackle complex stability issues at the device and module level (related to the processes involved in the fabrication).
- Develop updated test protocols and perform outdoor field performance testing of the perovskite modules.

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

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2023-D3-02-13: Operation, Performance and Maintenance of PV Systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
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: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. Its current contribution to global electricity demand is around 5% and is rapidly growing. PV already represents a share of more than 8% of the electricity generation in some EU Member States/Associated countries while penetration levels are expected to reach soon double-digit in Europe. It is within this scenario that the PV sector will ensure that the installed power capacity in GW can also reliably generate TWh of electricity for an extended lifetime.

Therefore, project results are expected to contribute to all of the following expected outcomes:

- Increase PV system performance, reliability, security and flexibility under various topology and operating conditions with enhanced digitalisation
- Increase utility-friendly integration of PV generation into the European energy system at high-penetration levels and the profitability of PV systems

Scope: Proposals are expected to demonstrate technical solutions, processes and models, which increase a PV system's operational performance, stability and reliability. The introduction of novel PV technologies and novel PV system designs makes the need of increased field performance and reliability a continuous industry demand.

More specifically, proposals are expected to:

- Demonstrate integrated multi-aspect sensing (optical, thermal, electrical) into PV modules to suppress degradation, detect unwanted operating conditions and avoid failures with emphasis on achieving high MWh/Wp (e.g. shade tolerant; more advanced electronic design with in-module components).
- Demonstrate smart control/tracking systems (e.g. coupled with real-time monitoring data, forecasting, EMS, etc.) for performance optimisation in specific PV applications (e.g. “self-protection” under extreme events in harsh environments like dust/snow storms).
- Demonstrate hybrid or integrated monitoring-diagnostic imagery solutions for maximum spatiotemporal granularity and diagnostic resolution. Multispectral imagery inspections linked with electrical signature, synchronisation of field techniques with monitoring.
- Apply edge AI and Big Data to improve the energy yield (advanced module control, self-reconfigurable topologies, etc.), module and plant models, monitoring and yield forecasting considering user behaviour and modelling of the entire electricity system including storage.

- Build large (time and scale-wise), wide (including not only yield but multisensory operational, thermal, mechanical and environmental data) and possibly publicly available datasets to enable, foster and empower AI for Digital PV at European scale.

- Demonstrate automated and predictive PV asset management software based on sensor-data-image fusion and/or AI / Machine learning techniques to reduce human effort and increase trustworthiness of current PV asset management software.

- Enable AI-based energy trading at plant level, taking care of specific climates /applications / conditions (snow, dust, environmental pollution, water…)/user behaviours.

HORIZON-CL5-2023-D3-02-14: Digital twin for forecasting of power production to wind energy demand

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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.
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). [174].

[174] This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link:

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

- Accurate and precise energy yield prediction to ease investment decisions based on accurate simulations that take into account simultaneously predictions on Renewable Energy Production, Energy Consumption and Price Predictions.
- Enhanced digital transformation of wind energy sector by delivering the next generation of digital twins.

Scope: The expected growth of both on-and offshore wind energy is enormous and many new wind parks are planned for the coming years. Experience from the existing wind farms shows the importance of a proper micrositing of the wind turbines as well their efficient interconnection within the farm. In addition, bringing wind farms together into clusters toward a wind power plant concept might induce long distance negative interaction between the farms, reducing their expected efficiency. This might happen both on- and offshore. The high amount of connected wind power and the expected increase during the coming years, requires that this technology has to be prepared to take a more important role as of its contribution to the reliability and security of the electricity system. The objective of this topic is to develop new digital twins to optimise the exploitation of individual wind farms (onshore, bottom-fixed offshore and floating offshore) as well as wind farm clusters, in view of transforming them into virtual power plants delivering a more reliable and secure electricity system. Such a digital twin is expected to integrate [at least three of the following bullet points]:

1. Wind and weather forecast models relevant for the full wind power production system (turbines, grid, transmission) (including the effects of external physical conditions such as temperatures, rain, turbulences, waves, and currents).
2. Spatial modelling: medium (within wind farms) to long distance (between/along wind farm clusters) wake effects.
3. Interconnection optimisation via simulations to satisfy grid connection requirements and agility in grid reconfiguration and provide ancillary services.
4. Include predictive maintenance, structural health and conditional monitoring, and
5. End user location and needs.

The digital twin will improve accurate energy yield prediction and will balance supply and demand side needs and will help to ease investment decisions based on accurate simulations. The models should incorporate other relevant parameters influencing the siting of wind farms, such as ground conditions, noise impacts and environmental impacts as well as representing the complex system in a map view format while considering time series data of each and

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https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

every asset. Infrastructure modelling of each and every asset should be executed via independent profiling based on past performance data and contextual data in view to deliver prediction at the level of each and every asset with as much accuracy as possible".

The project should focus on offshore or on onshore wind power systems and make optimal use of previously developed models. Validation should be carried out with data of existing wind farms. Cooperation with wind energy suppliers, OEM's, developers and O&M services can make the available data more accurate, resulting in better, more sustainable and eventually circular products and sector. The project should also sufficiently invest in delivering a cyber-secure system. The projects is expected to build also on the digital twins developed under Destination Earth, which envisage to develop a high precision digital model of the Earth to model, monitor and simulate natural phenomena and related human activities.

For the offshore digital twin projects the impact of other blue economy sectors, islands, different land-sea interactions for near shore wind farms should be considered.

For onshore digital twin projects, the build environment and different landscapes should be considered, and cooperation is envisaged with the selected projects under topic HORIZON-CL5-2021-D3-03-05 Wind energy in the natural and social environment.

It is expected that one project on offshore digital twin will be funded and one on onshore digital twin.

To support rapid market uptake, widespread application and further innovation based on the developed solutions, projects are invited to use Open-Source solutions when appropriate and clarify in case they choose not to use Open Source, so that they can support the planning of future large scale offshore wind installations. Free licensing is also a possibility to consider to support rapid market uptake.

Selected projects will be required to share knowledge. Projects will acquire performance-related data in a standard format to support advancement and validation of R&I for the benefit of all projects through Artificial Intelligence methods. This data and relevant meta-data may be shared with other projects (not supported through Horizon Europe, including relevant projects supported through the Innovation Fund) on reciprocal terms, preferably leveraging on the tools and services provided by the European Open Science Cloud (EOSC) and exploring workflows that can provide "FAIR-by-design" data, i.e., data that is FAIR from its generation, and with EU-based researchers having a legitimate interest. The selected projects are expected to cooperate with the project selected under the call [CSA for data-sharing between renewable energy R&I project to advance innovation and competitiveness].

The selected projects are expected to contribute to the BRIDGE initiative[175], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

[175] https://www.h2020-bridge.eu/

HORIZON-CL5-2023-D3-02-15: Critical technologies to improve the lifetime, efficient decommissioning and increase the circularity of offshore and onshore wind energy systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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: Project results are expected to contribute to at least two of the following expected outcomes:

- Improved overall lifetime, reliability, recyclability, sustainability, operability and maintainability of onshore and offshore wind turbines and foundations/substructures.
- Enhanced overall sustainability of wind energy systems based on mainstreamed Life Cycle Analysis addressing social, economic and environmental aspects, as well as improved circularity.
- Mainstreamed affordable high life-cycle performance, life extension, more efficient decommissioning, and improved circularity of wind turbine components.
- Potential new markets in wind turbines recycling and/or re-purposing.

Scope: Innovative technologies to improve the lifetime, efficient decommissioning and increase the circularity of wind energy systems. Project can address one of the following points:

- Development of improved, more damage-tolerant materials (composites and adhesives) considering different external conditions in which the materials are used (consider very low/high temperatures, ice, corrosion, erosion.

- The development of improved manufacturing procedures for turbine components and construction methods for wind turbine farms and design methods for wind turbine components.
- The development of materials and interfaces for joints of major load-carrying parts like main spars (split blades and tower parts).
- The development of bio-based fibres and resins with improved mechanical properties.
- Lifetime extension by innovative design for increased resilience and repair solutions for in the first-place wind turbine components like blades, drive train and generators', and support structures.
- New installation, decommissioning, and condition monitoring technologies and operation and maintenance methodologies (e.g. remote controlled devices for in situ repairs by robots).
- New efficient recycling technologies for wind energy components.
- Alternatives in materials/new advanced materials.
- New technologies for effective and environmentally friendly decommissioning of wind energy systems.

But it is not excluded to consider other solutions.

This R&I need is critical for onshore wind given the large volumes of capacity to be decommissioned in the next decade. The R&I need was also identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to 'systematically integrate the principle of 'circularity by design' into renewables research & innovation'.

HORIZON-CL5-2023-D3-02-16: Accelerating the green transition and energy access in Africa

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Innovation Actions
Eligibility	The conditions are described in General Annex B. The following

conditions	exceptions apply: The following additional eligibility criteria apply: For the consortium, in addition to the standard eligibility conditions for consortia, at least two entities established in at least one African Union member state must be part of the consortium. 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.
Award criteria	The criteria are described in General Annex D. The following exceptions apply: For the criterion **'Quality and efficiency of the implementation'**, in addition to its standard sub-criteria, the following aspect shall constitute a major element: Proven access to necessary land and / or permits for operation at the time of application and / or convincing risk management regarding delayed availability of land or permits. Risk management can include go / no-go decisions at mid-term.

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

- Technologically reliable and economically viable renewable energy solutions by 2030.
- Improve climate adaptation and/or climate mitigation potential of the solutions compared to other technologies/solutions.
- Strengthening of the joint EU-AU Climate Change and Sustainable Energy Collaborative Partnership efforts, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.
- Proven positive environmental, health, climate, social and economic impacts of the renewable energy solutions.
- Acceleration of the achievements of the African countries' targets of the Paris Agreement.

Scope: The proposal should demonstrate innovative sustainable renewable energy solutions that improve climate adaptation and/or mitigation potential compared to other technologies/solutions in the African social, economic and environmental contexts. The proposal may address development of renewable energy sources, including solutions for off-grid communities, and their integration into the existing energy system. Proposals should

consider the generation of renewable energy, and where relevant the transmission, and the use of storage/battery systems.

The action should cover either urbanised or rural contexts in Africa. It should contribute to reducing the stress on the water-energy-food nexus, with the aim of providing sustainable renewable energy access and creating other socio-economic benefits such as improved health, economic wealth and jobs.

Actions should design, construct, commission and operate the demonstration installation. Actions should also develop and implement a tailored value chain approach, identifying the most suitable manufacturing value chains, on the basis of the local context, local material supply chain(s) and local workforce, with the objective of ensuring sustainable local economic development. African SMEs are expected to play an important role in the overall value chain and to contribute in the identifying the needs. Actions should also include the identification of technical, vocational and educational needs of the workforce and propose relevant training and qualification activities. Actions should finally define a market and business strategy that could take into consideration funding from financial instruments and aid programmes to ensure impact through a quick and viable commercial take-up of the technological solution demonstrated.

Social innovation should be considered. The business plan should include appropriate consideration of available financial support instruments (local, regional and/or international) to enhance the speedy market deployment of the solution.

Proposals should include a life cycle analysis showing the impact of the proposed solutions when compared to other technologies/solutions on the environment, on climate change targets and on the social and the economic dimensions, taking a cradle to grave viewpoint. The life cycle analysis should take a cradle to grave approach. Proposals should adopt a circular economy approach.

As the demonstration installation will be located in Africa, relevant African partners have to participate in the implementation of the project. A balanced involvement in the activities of the projects of European and African partners will be considered an asset in the evaluation.

Actions should also participate in and contribute to the African Union[176] - European Union collaborative research action on Climate Change and Sustainable Energy, in particular through cooperation/collaboration with the project LEAP-RE, ", www.leap-re.eu.

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2023-D3-03

Conditions for the Call

Indicative budget(s)[177]

[176] "African Union member states" includes countries whose membership has been temporarily suspended.

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[178]	Indicative number of projects expected to be funded
		2023		
Opening: 04 May 2023 Deadline(s): 10 Oct 2023				
HORIZON-CL5-2023-D3-03-01	RIA	9.00	Around 3.00	3
HORIZON-CL5-2023-D3-03-02	IA	12.00	Around 6.00	2
HORIZON-CL5-2023-D3-03-03	IA	11.00	Around 11.00	1
HORIZON-CL5-2023-D3-03-04	IA	11.00	3.00 to 4.00	3
HORIZON-CL5-2023-D3-03-05	IA	5.00	Around 5.00	1
HORIZON-CL5-2023-D3-03-06	IA	10.00	Around 5.00	2
HORIZON-CL5-2023-D3-03-07	RIA	6.00	Around 3.00	2
HORIZON-CL5-2023-D3-03-08	CSA	0.60	Around 0.60	1
Overall indicative budget		64.60		

General conditions relating to this call	
Admissibility conditions	The conditions are described in General Annex A.
Eligibility conditions	The conditions are described in General Annex B.
Financial and operational capacity and exclusion	The criteria are described in General Annex C.
Award criteria	The criteria are described in General Annex

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

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

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

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-01: Increasing the efficiency of innovative static energy conversion devices for electricity and heat/cold generation

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
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 5-6 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to develop further the harvesting of renewable energy in areas/conditions where other conversion systems are less efficient, less convenient or not possible.

The results are expected to contribute to at least three of the outcomes in A and B:

A. Increased potential for wider application of electricity and heat/cold static generators due to increased efficiency of energy conversion devices using physical effects such as:

- Thermoelectric -> Thermoelectric Generators (TEG)
- Thermovoltaic -> Thermovoltaic Generators (TVG)
- Thermionic -> Thermionic Generators (TIG)
- Pyroelectric-> Pyroelectric Generator (PEG)
- Electrocaloric -> Electrocaloric Generator

B. Optimised construction and application of the above-mentioned devices for:

- heat recovery applications with electricity generation;
- heat/cold generation from electricity;
- applications in areas such as industrial, automotive, solar, geothermal, data centres, buildings applications, etc.

Scope: Projects are expected to implement both the activities in (1) and the validation/demonstration in (2) for the technologies listed above addressed individually and/or as combination of them or with other generation technologies (e.g., Thermionic Photovoltaic TIPV) as described below:

1. Development of at least three of the above-mentioned technologies involving the activities listed below. These can be complemented among them and/or with others pertinent to the topic.

- Simulation, analysis, design, test and validation/demonstration of innovative generators such as the ones described above converting directly heat/cold into electricity with applications in energy waste recovery (e.g., industry, geothermal, data centres, buildings, automotive, etc.).
- Simulation, analysis, design, test and validation/demonstration of innovative generators converting electricity directly in heating or coolin systems (e.g., in industrial processes such as metallurgy, semiconductor lithography, etc., to cool or heat control elements, to cool Li-Ion-Batteries of electric cars, temperature control in data centres, etc.).
- The development of new materials to overcome the drawbacks of the above-mentioned technologies such as of their interdependent electrical and thermal properties, etc.
- Innovative designs of the above-mentioned types of generators that allow better integration into energy conversion systems, from the point of view of efficiency and environmental impact.
- Potential use of nanotechnology for the development of the above-mentioned innovative energy conversion technologies.

2. Validation/demonstration of the activities developed in (1) with at least one pilot for each technology in different EU Member States/Associated Countries.

HORIZON-CL5-2023-D3-03-02: Integration of renewable gases, other than hydrogen or methane, and which have not access to gas grids and interfacing with electricity and heat sectors

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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 the following expected outcomes:

- Accelerate the integration of unrefined renewable gaseous fuels in the energy system.
- Increase flexibility, reliability and security of renewable energy supply in the energy sector.
- Increase integration of electricity and heat/cooling sectors with gas grids.

Scope: Demonstration of decentralized production of renewable gaseous energy carriers other than hydrogen and purified biomethane, namely biogas and syngas for example, and its integration in local energy systems and/or energy consuming industries for direct electricity and heat and cooling production. Demonstration of the integration of small and flexible modular gas production units, its associated infrastructure and development of digital interfaces for the connection to electricity and heat/cooling sectors are included. The integrated modules and components should be optimized to increase flexibility, security, affordability, and robustness to the local energy supply. Conditions for injection to the grid of renewable unrefined gases should be identified. A techno-economic analysis should be

included to address the cost-effectiveness of the integrated solution. A life Cycle Analysis should be carried out for the assessment of the GHG emission reduction due to the renewable gas integration. Interfaces to governance issues of system integration, as for example market design, network regulation, CO_2 market, renewables support, etc. should be addressed. Effects of Community involvement should be addressed with an analysis of socioeconomic sustainability.

HORIZON-CL5-2023-D3-03-03: System approach for grid planning and upgrade in support of a dominant electric mobility (vehicles and vessels) using AI tools

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 11.00 million.
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.

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

- AI-based prediction of most convenient locations that optimize grid resources and upgrades around recharging pools for EVs and electric HDVs.
- Developing of spatial mapping models and software tool for location decision-making with a comprehensive focus, including major highways, industrial zones (depot charging), urban nodes (e.g., for overnight charging) and less-densely populated areas.
- Simulation, analysis, design, test and demonstration of smart and bidirectional charging schemes and their integration into flexibility markets that allow to minimise the impact on grid planning and connection of high-power recharging pools for recharging EVs, and especially HDVs on more cost-intensive locations, and that ensure benefits to consumers based on smart charging energy service models.

- Exploration of the impact of different charging methods, including cable-charging, wireless charging and electric road systems covering either catenary as inductive coils embedded in the road.

- Analysis, design, testing and developing of a cyber security model that can simulate and accurately represent attack propagation from recharging infrastructure entry vectors, informing the development of efficient strategies and lines of defence to mitigate these vulnerabilities for the different relevant stakeholders.

Scope: The activities are expected to include at least the following aspects:

- Definition and development of new AI-based tools to predict, estimate and plan the deployment and associated challenge for utilities (from an EV recharging ecosystem viewpoint - CPO, DSO and TSO) on how to deal with the increasing upcoming demand in numerous new locations, particularly during peak periods.

- Understanding on how to effectively deploy the required grid connection (and power) in less densely populated areas, exploring the impact of installation of batteries to expand the grid in combination with renewables.

- Development of a coherent energy system planning for electric mobility, considering both the needs and impact for recharging of EVs and onshore power supply of vessels in maritime ports and inland waterways.

- Development of new services for consumers (EV and HDV owners, leasers, etc.) based on smart charging that valorise the flexibility in the wholesale, home optimisation and/or grid services markets. Integration of smart charging services with flexibility from other devices (e.g. demand response) would be an added value for the project.

- There is an increasing risk for the occurrence of a scenario where EVs and/or recharging stations could be hacked simultaneously, causing a disruption to grid operations, propagating rapidly with dire consequences, such as blackouts and overall affection of the frequency stability of the grid. The project should bridge the gap between recharging infrastructure operators, EVs and the grid (DSOs, TSOs), identify existing weaknesses and risks for attack spread.

- The developed solutions should assess their environmental impact in particular with regards to their energy consumption.

The selected projects are expected to contribute to the BRIDGE initiative[179], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

[179] https://www.h2020-bridge.eu/

HORIZON-CL5-2023-D3-03-04: Digital tools for enhancing the uptake of digital services in the energy market

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 11.00 million.
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' results are expected to contribute to all of the following outcomes:

- Development and uptake of innovative data-driven cross-sector integrated services, solutions and products using cross-sectorial data resulted from other sectors than energy (e.g. data economy, health, finance, security) that empower consumers and facilitate consumer investment in the energy transition (e.g. renewables, energy efficiency, renovation, demand response, storage).

- Development and fast market-uptake of digital twin models of household energy consumers to help consumers, citizens, energy suppliers, aggregators and energy communities to optimise data-driven energy (and other sector) services and to enhance digital energy literacy.

- Greater access for consumers to the wide range of emerging services and applications that will be present in the market resulting from data sharing and benefiting from increased interoperability.

- Increased simplification of management and improvement of quality of new and current energy services and new digital platforms, smart meters and tools to provide consumers with seamless omni-channel experiences.

- Assessment of the implications for market design (energy and flexibility markets) of a wide uptake of digital tools and propose relevant modifications to flexibility services and related processes to contract, activate, measure and settle flexibility.

- Creation of value and direct benefit for the consumers and support digital empowerment and energy literacy of citizens: European citizens are educated, motivated, and empowered to use digital tools to be an active participant in the just energy transition.

Scope: Digitalisation develops faster than the ability of society to adjust. Digital technologies are a driving force for empowering citizens in taking on an active role in the just energy transition. Increased acceptability of new digital technologies is pivotal: actions should focus on benefits of new digital services and users experience to overcome the expected friction of end-consumer on boarding, developing innovative tools for engagement and literacy. Social innovation tools and multi-disciplinary approaches and engagement of policy makers at various levels, the private sector, civil society and citizens at large are required.

Accordingly, proposed activities will address all of the following:

- Use the data real time provided by real time sensors/ Internet of Things and real time computing resulting from other sectors than energy (e.g. data economy, health, finance, security) to generate new businesses and new ways of benefiting the economy and society by developing of innovative data-driven cross-sector integrated services, solutions and products.

- Help consumers and citizens navigate the new digital technologies entering the energy market, taking into consideration the cross sectorial dimension alongside the sector-specific one, also exploring the possibility of using, among others, AI-based assistant tools.

- Trigger and support the development of a digital tool allowing citizens to visualise and access to all the energy-related data they produce and share with third parties, thus helping to exert their right to understand and control their data.

- Test the developed cross-sector services in at least 3 countries. In the selection of pilots, gender, demographic, geographic and socio-economic aspects should be duly taken into account.

- Develop and test, in at least 3 countries, a digital twin of the (household) energy consumer, making use of AI to assist the consumer (both in terms of optimising the service as well as enhancing digital energy literacy and enhancing understanding and trust of the AI used).

- The digital twin solutions should be developed and made available as Open-Source solutions, while making sure that contributors are recognised and fairly compensated, respecting well defined rules and within a network of trusted data, which guarantees security and sovereignty of data and services in an Open Source way so that the developed software is available.

- Contribute to the communication, outreach and dissemination strategy of the Communication on Digitalisation of the Energy System.

Projects are required to utilize the data exchange infrastructure that is being developed under ongoing EU-funded under Horizon 2020, Horizon Europe and the Digital Europe Program.

The project is required take into account, and collaborate with, where considered necessary, existing Living Labs (e.g. EnergyVille, TomorrowLab and living labs funded entirely by EU projects as study or demonstration site) to test integrated consumer services the ongoing relevant Blueprint projects from the Erasmus + program, relevant initiatives by Digital Innovation Hubs, the European Climate Pact, EC Digital Education action plan and any other relevant initiative.

Projects are required to seek synergies with Horizon Europe instruments, including those of bottom-up nature like ERC, MSCA, EIT KICs, as well as its European partnerships.

Cooperation with activities of the Green Powered Future Mission (Pillar 3) of Mission Innovation is encouraged[180].

The selected projects are expected to contribute to the BRIDGE initiative[181], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Moreover, projects are expected to take into account the outcomes of the work of the Citizens and Consumers Engagement Working Group and data coming from the Consumers Empowerment Benchmark developed by the European Commission.

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

HORIZON-CL5-2023-D3-03-05: Creation of a standardised and open-source peer-to-peer energy sharing platform architecture for the energy sector

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[180] Applicants are reminded that legal entities established in China are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.

[181] https://www.h2020-bridge.eu/

Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
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.

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

- Develop an independent, EU-validated flexibility and peer-to-peer trading solution for consumers willing to engage in such operations, to the benefit of the integration of Distributed Energy Resources (such as solar panels, batteries and electric vehicles, but also demand-response and flexible heat pumps and heaters considered as a resource) within the electricity network.
- Such an alternative should be open source, freely accessible, free of IPR, easy to maintain, and ensure that the final ownership of the tools can remain in community hands, and that these tools are available for reuse.
- Increase consumer engagement and tool's acceptability.
- Illustrate the relevant services that are supported by this peer-to-peer trading platform (flexibility services for TSO, DSO, self-consumption).
- Ensure policies of operations, integration and usage of blockchain technologies and underlying data for all stakeholders.
- Ensure interoperability and contribute to standardisation of blockchain energy applications

Scope: The activities include, but are not limited to:

- Defining the core operations that a flexibility and peer-to-peer trading platform should execute in order to:
    - Guarantee optimal valorisation and integration of DER (such as solar panels, batteries and electric vehicles, but also demand-response and flexible heat pumps and heater considered as a resource) within the electricity network.

  - Take into account network constraints, including through the use of price signals to foster flexibility.
  - Meet the local consumers' needs and characteristics.

- Developing an AI-based software that uses machine learning processes to integrate core operations and local grid constraints (including when channelled through price signals) in order to adapt to variations and changes in grid conditions.
- Testing and simulation cases for blockchain-based trading operations following an agile methodology with the objective to get a fully functional trading tool within the project lifetime. The design of the platform should reflect the multi-actor, open-ended nature of decentralised use of energy. Proposals should account for a complex system change process, and prescribe evolutionary pathways for the platforms, account for their socio-technical interdependencies, and define and validate feasible entry points.
- Developing field studies in citizen energy communities / renewable energy communities to integrate bottom-up approaches.
- Setting rules for using the tool
- Involving energy cooperatives or citizen energy communities (see Article 16 of the Commission's Directive 2019/944 on common rules for the internal market for electricity (IEMD)) / renewable energy communities (see Article 22 of the Commission's Directive 2018/2001 on the promotion of the use of energy from renewable sources (RED II)) in each selected project and ensure that the final ownership of these tools can remain in community hands, and that they are available for reuse (a particular consideration will be taken with respect to data security and potential related restrictions thereof).
- Developing an open, available and operational platform to strengthen business models, and define which these business models are.
- Exploring and comparing advantages / disadvantages of existing and new market making methods (Order Book-based systems and Liquidity pool-based Automated Market Makers) for a peer-to-peer energy exchange.
- The project should be developed by taking into account both a technology performance perspective and a long-term sustainability roadmap.

The developed solutions should be freely available to citizens, energy cooperatives and citizen/renewable energy communities.

Solutions should be developed and made available as Open-Source solutions, while making sure that contributors are recognised and fairly compensated, respecting well defined rules and within a network of trusted data, which guarantees security and sovereignty of data and services.

The selected projects will cooperate and with other relevant projects through regular common workshops, exchange of non-confidential reports, etc.

The selected projects, especially those that are testing peer-to-peer feasibility in real conditions and environments (such as living labs or other types of sandbox initiatives), are expected to contribute to the BRIDGE initiative[182], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

Solutions should be developed considering integration into existing power markets where appropriate. The selected projects should associate energy regulators in their governance and should preferably be located in the territory of EU Member States/Associated countries where few peer-to-peer energy trading pilot projects have been setup so far.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. This is all the more important in the project at hand that a modification of consumers incentives (through price-signals for instance) can trigger changes of behaviour, which in turn can have positive effects on the electricity system, and interesting applications in terms of flexibility services, optimization of use of excess RE production, as well as congestion management.

HORIZON-CL5-2023-D3-03-06: Components and interfacing for AC & DC side protection system – AC & DC grid: components and systems for grid optimisation

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
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).

[182] https://www.h2020-bridge.eu/

Technology Readiness Level	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

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

A. Protection:

- AC & DC side protection strategies and readiness of their functional design, to support grid optimal architecture planning and prepare project tendering.
- Methodology to assess admissible temporary loss of transmitted power in case of DC fault.
- Multi-vendor interoperable MVDC/HVDC grid protection strategies and design.
- AC & DC side protection system functional design for fully selective, non-selective and partially selective fault clearing strategies, including the connection to low-inertia AC systems.

B. Congestions in AC or DC grids:

- Innovative Power Electronics-based technologies properly placed in the grid to address congestion due to the injection of decentralised energy in a centralised-based electricity system.
- Optimisation of the power flows by shifting power transfer from loaded to less loaded lines.
- Grid reinforcement avoidance.

Scope: Projects are expected to implement activities in (1) and the practical demonstration in (2) as described below:

1. Development of R&I activities, methodologies and tools for at least two of the sub-topics in A (a, b or c) and B. These can be developed/complemented among them and/or with others pertinent to each sub-topic:

A) Protection:

a. Methodology to assess admissible temporary loss of transmitted power in case of DC fault:

- AC-DC transient stability, when DC transmitted power is temporarily and partially interrupted, in case of a DC fault.
- Impact of reactive power supply transient interruption (converter blocking).
- In case of MVDC/HVDC-connected Off-Shore Wind farm: coordination of control actions from MVDC/HVDC and wind turbines.

- Anticipation of new system dynamics due to high PEID penetration.
- Impacts of partially selective and non-selective versus fully selective DC fault-clearing strategies.
- Recommendation for AC-DC system design and DC protection design.

b. Multi-vendor interoperable MVDC/HVDC grid protection

- Improved methodologies for the determination of functional requirements of DC grid protection in a technical and vendor neutral manner.
- Standardised validation tests for de-risking interoperability issues.
- Specification of protection component and auxiliary ratings.
- DC substation Communication architecture and protocols (e.g., IEC 61850 for DC).
- Protection system simulation models and information exchange.

c. HVDC grid protection strategies and design

- Methodologies for the protection of mixed (OHL/cable, bipolar/monopolar) DC grids.
- Methodologies to optimally determine the optimal MVDC/HVDC grid protection system, including combined selective, non-selective and partially protection schemes within the same DC grid.
- Development of converter assisted MVDC/HVDC grid protection.
- DC station design and optimisation from protection point of view.
- AC & DC side protection system functional design for fully selective, non-selective and partially selective fault clearing strategies, including the connection to low inertia AC systems

B) Congestions in AC or DC grids:

- Simulation, analysis, design, development, test and demonstration of advanced Power Electronics-based equipment inserted appropriately in specific points in the grid to decongestion the lines or cables.
- Cost Benefit Analysis compared to other solutions (e.g., the use of DC systems, etc.) at system level and covering the operating life of the equipment.

2. Demonstration, test and validation of the activities developed in (1) in at least two pilots in different EU Member States/Associated Countries.

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-07: Digital solutions for defining synergies in international renewable energy value chains

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
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). The consortium must include, as an associated partner or beneficiary, at least one legal entity established in a Mission Innovation Country[183], not being Member State or Associated Country.
Technology Readiness Level	Activities are expected to achieve TRL 5 by the end of the project – see General Annex B.

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

- Advance the European and global scientific basis, European leadership and global role in the area of renewable energy and renewable fuels and related energy value chains while creating evidence for policy making by developing novel digital solutions.
- Provide digital breakthrough solutions for promoting the increase of the global renewable energy share.
- Reinforce the European scientific basis through international collaboration while increasing the potential to export European renewable energy technologies and ensuring political priorities in the context of sustainable global energy value chains.

[183] http://mission-innovation.net/

- Improve reliability of system components, advanced and automated functions for data analysis, diagnosis and fault detection, forecasting and model-predictive control frameworks, ancillary services for the stability of the network; maintenance planning and/or reporting.

Scope: Development of novel real time and open data monitoring and/or simulation solutions (e.g. including digital twins) for sustainable energy production and consumption, predictive modelling and artificial intelligence for the analysis of international renewable energy value chains and for internationally aligned decision-making in cooperation with international partners from Mission Innovation Countries. To ensure trustworthiness, wide adoption by user communities and support EU policy-makers, actions should promote the highest standards of transparency and openness, going well beyond documentation and extending to aspects such as assumptions, models and data related to renewable energy and fuels.

The current topic is an amended republication of topic HORIZON-CL5-2022-D3-02-01 which has been cancelled.

Cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D3-03-08: Support to the SET Plan IWG on hydrogen

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 0.60 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 0.60 million.
Type of Action	Coordination and Support 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).

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

- Organisational, logistic and secretarial support provided to the SET Plan Implementation Working Group on hydrogen.

- Smooth implementation through supporting the actions of the SET Plan for hydrogen in the coming years covering the whole value chain.

Scope: The Implementation Working Group (IWG) on hydrogen set up in 2023 aims at implementing part of the Strategic Research and Innovation Agenda (SRIA) of the European Research Area (ERA) pilot on green hydrogen, and coordinating the work on hydrogen previously split between different IWGs of the SET Plan. This ERA Pilot on green hydrogen SRIA addresses specifically the need to ensure mutual coordination on an ongoing basis among national and regional hydrogen R&I programmes. It calls for, through a bottom-up approach, more ownership by member states and associated countries, which also means more financial and political commitment. It aims to maximise cooperation and synergies among member states and associated countries, and avoid inconsistencies, duplications, and fragmentation of measures. The activities of the hydrogen IWG build on the SRIA and range from the support of the development of hydrogen technologies to the fostering of collaboration and coordination within the SET Plan countries to ensure their active involvement. The support action is intended to facilitate the work of the hydrogen IWG by further defining its mission, supporting the preparation of the Implementation Plan (IP) on hydrogen and ensuring synergies with other SET Plan IWGs, domains and objectives, with activities focusing on:

- Organisational support to the Implementation Working Group on hydrogen.
- Analysis of the ERA pilot on green hydrogen SRIA and identification of the actions to be taken on by the IWG in the IP.
- Proposals to further develop the work initiated by the SRIA, for the parts relevant for the SET Plan.
- Coordination with other SET Plan IWGs to ensure complementarity of the actions.
- Coordination with other initiatives/projects and establishment of links with stakeholder's fora.
- Facilitation of exchange between member states and stakeholders on best practices and lessons learned.
- Dissemination and networking activities with other existing ETIPs and IWGs (e.g., joint workshops, thematic conferences, webinar series, regular exchanges, etc.).
- Development and implementation of robust outreach approaches, development of assessments of risks (including environmental ones) and design and implementation of solutions, and societal engagement actions to span across the EU and Associated Countries.
- Organisation and management of documents and files with feed-in of relevant outputs of this CSA into the SET Plan information system (SETIS).

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2024-D3-01

Conditions for the Call

Indicative budget(s)[184]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[185]	Indicative number of projects expected to be funded
		2024		
Opening: 12 Sep 2023 Deadline(s): 16 Jan 2024				
HORIZON-CL5-2024-D3-01-01	IA	24.00	Around 12.00	2
HORIZON-CL5-2024-D3-01-02	IA	6.00	Around 3.00	2
HORIZON-CL5-2024-D3-01-03	IA	20.00	Around 10.00	2
HORIZON-CL5-2024-D3-01-04	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-05	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-06	RIA	9.00	Around 3.00	3
HORIZON-CL5-2024-D3-01-07	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-01-08	IA	38.00	18.00 to 20.00	2
HORIZON-CL5-2024-D3-01-09	COFUND	10.00	Around 10.00	1
HORIZON-CL5-2024-D3-01-10	RIA	27.00	Around 3.00	9
HORIZON-CL5-2024-D3-01-11	IA	16.00	Around 5.00	3
HORIZON-CL5-2024-D3-01-12	IA	10.00	Around 5.00	2

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

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

HORIZON-CL5-2024-D3-01-13	RIA	13.00	Around 6.00	2
HORIZON-CL5-2024-D3-01-14	RIA	13.00	Around 4.00	3
HORIZON-CL5-2024-D3-01-15	RIA	16.00	5.00 to 5.50	3
HORIZON-CL5-2024-D3-01-16	IA	8.00	Around 8.00	1
HORIZON-CL5-2024-D3-01-17	IA	12.00	Around 6.00	2
Overall indicative budget		246.00		

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

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-01-01: Alternative equipment and processes for advanced manufacturing of PV technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 24.00 million.
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: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important to enhance affordability, security of supply and sustainability of PV technologies along with further efficiency improvements. To ensure security of supply, retaining the whole value chain in EU Member States/Associated countries is essential; technology de-risking is a necessary step towards this direction. Consequently, project results are expected to contribute to all of the following outcomes:

1. Contribute towards establishing a solid European PV innovation and production base.
2. Reduce the CAPEX and OPEX in the PV solar production chain, ultimately leading to cheaper modules and lower LCOE.
3. Reinforce the sustainability of the European PV value chain building a secure, resilient, and diverse domestic energy sector industrial base.

Scope: Proposals are expected to:

- Demonstrate alternative processes and equipment for PV manufacturing with reduced CAPEX, OPEX, energy and material consumption and implement Industry 4.0 concepts.
- Increase the productivity and sustainability of large-scale PV manufacturing equipment and processing, for example by the enhancement of: i) throughput (e.g. wafers or roll area /time or module area/time) ii) yield (process & quality control) iii) availability (e.g. optimisation of uptime & service time) and iv) quality control.
- Involve multidisciplinary consortia including industrial partners.

A plan for the exploitation and dissemination of results should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. The exploitation plan should include preliminary plans for scalability, commercialisation, and

deployment (feasibility study, business plan) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

HORIZON-CL5-2024-D3-01-02: Low-power PV

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 5-7 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). [186].

Expected Outcome: Energy autonomous applications capable of generating their own energy by harvesting ambient energy from the environment to completely eliminate the need for a power source or at least assist it, have gained significant interest in recent years. Photovoltaic energy conversion is a viable choice for energy harvesting due to its high conversion efficiency and compatibility with low lighting conditions.

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

Consequently, project results are expected to contribute to the following expected outcome:

- Increase the potential of PV for low power, low irradiation applications (harvesting energy in low light intensity and/or artificial light conditions).

Scope: Photovoltaic energy harvesting in low light conditions such as indoors, or under artificial or diffuse light can be used to power sensors, as well other low-power electronics. Efficient energy harvesting combined in an energy system with storage unit and low power electronics, can enable a wide range of applications, integrating new functionalities, for example autonomous sensors, domotics, remote monitoring, variable transmission applications and portable devices in general.

Proposals are expected to validate novel and low-environmental impact PV materials, PV architectures and suitable substrates for the specific low power applications that take into account the light intensity, light spectrum and application itself. PV system performance is expected to be tailored to meet the application-specific power and energy requirements and application – related standards. Proposals should include a clear definition of the use case and lifecycle considerations, e.g. business models, circularity by design aspects, certification, etc.

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2024-D3-01-03: Demonstration of improved intermediate renewable energy carrier technologies for transport fuels

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
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.
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). [187].

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

- Support de-risking the technology, boost scale-up of flexible intermediate bioenergy and synthetic renewable energy carriers and contribute to their market up-take.
- Respond to short- and medium-term needs for renewable fuels in transport.
- Increase flexibility, reliability and security of renewable energy supply in the transport sector.
- Increase available options for better integration of the energy system linking renewable energy production, storage and use via renewable energy intermediates.

Scope: Demonstration of technologies for the production of advanced intermediate bioenergy and synthetic renewable energy carriers from biogenic residues and wastes, microalgae, biogenic CO, CO2 or nitrogen and renewable hydrogen and all forms of renewable energy with reduced cost and GHG emissions above the state of the art. Proposals are expected to demonstrate that conversion technologies have already reached pilot scale TRL 5. The finished quality is expected to be suitable so that the intermediates can be either directly upgraded in existing refinery infrastructures and/or further purified and processed in existing chemical infrastructures to drop-in liquid and gaseous advanced biofuels and synthetic renewable fuels, or directly used for shipping propulsion or in other off-road transport. Examples are demonstration of production of bio-oils, raw alcohols, bio-liquids, biogas, syngas and thermally pre-treated solid biomass fuels from biogenic residues and wastes and microalgae oils through chemical, biochemical, thermochemical, biological, electrochemical pathways, as well as synthetic renewable analogues. The integration of these intermediates in transport and their application in hard to electrify transport sectors should be presented. The

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

logistics for transportation and storage of the intermediates should be addressed. The sustainability and GHG reduction should be addressed on a life-cycle assessment basis. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, the InvestEU, the EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2024-D3-01-04: Improvement of light harvesting and carbon fixation with synthetic biology and/or bio-inspired//biomimetic pathways for renewable direct solar fuels production

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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 3-4 by the end of the project – see General Annex B.

Expected Outcome: Project results are expected to contribute to at least 3 of the following expected outcomes:

- Availability of disruptive and sustainable solar fuel technologies in order to accelerate the replacement of fossil-based energy technologies with more efficient use of primary solar energy in solar fuel production.
- Reduced cost and improved efficiency of solar-based renewable fuel technologies and their value chains by addressing rate-limiting steps in the solar fuels value chain.
- Increase technology leadership, competitiveness and technology export potential of European industry in possibly game-changing solar fuel and synthetic biological technologies.

- Enhanced sustainability of solar fuels, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- Reinforced European scientific basis and European export potential for renewable energy technologies through international collaborations (e.g., the AU-EU Climate Change and Sustainable Energy partnership, the missions and innovation communities of Mission Innovation 2.0).
- Increasing the European energy security and reliability by improving the solar fuel conversion efficiency as well as maintaining and fostering the European global leadership in affordable, secure and sustainable solar fuel technologies.

Scope: Development of novel in-vivo or in-vitro biochemical and/or bio-inspired/biomimetic pathways for solar fuel production with increased efficiency in comparison to light and dark reactions of natural photosynthesis by synthetic biological and/or bio-inspired/biomimetic approaches. The aim is to achieve a significant improvement of components of both, light harvesting and carbon fixation, which are rate limiting for the conversion of solar energy to renewable fuels. Proposals are expected to include case studies for analysing the potential and impact of the technology for future application at scale and analyse possible interfaces with other solar fuel technologies, with a particular focus on socioeconomic and environmental sustainability including circular economy, social, economic and environmental aspects and cost-effectiveness. All relevant aspects of safety of the technology are expected to be addressed. Hydrogen as a fuel and end-product is excluded.

Projects are expected where possible to collaborate with and contribute to the activities of the Coordination and Support Action funded under the topic HORIZON-CL4-2021-RESILIENCE-01-16

HORIZON-CL5-2024-D3-01-05: Development of carbon fixation technologies for biogenic flue gases

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Availability of disruptive sustainable bioenergy technologies with negative carbon dioxide emissions.
- Increase technology leadership, competitiveness and technology export potential of European industry.
- Reduced cost and improved efficiency of sustainable bioenergy technologies and their value chains.
- Enhanced sustainability of bioenergy, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.

Scope: Development of biological and chemical solutions to use the effluent gases from bioenergy combustion systems and upgrade biogenic carbon emissions for the production of renewable energy carriers with renewable hydrogen for later reuse as feedstock for energy needs and achieving carbon circularity. This requires system components (e.g. catalysts), which are cost-effective and robust to flue gas toxicity and interface with the underlying bioenergy combustion system without compromising system performance in respect of technical efficiency and sustainability.

The effluent fixing solution has to be implemented in the conditions of the bioenergy combustion system and provide an integrated structure at the TRL requested. The reuse of the biogenic emissions should be addressed. The assessment of the combustion gas upgrading should be done at pilot scale and cost analysis of how this is a beneficial carbon capture and use solution should be provided.

Socio-economic aspects including SDGs and impacts when applying such solutions in regions in transition from coal or other fossil fuels should be analysed and illustrated in the proposal.

HORIZON-CL5-2024-D3-01-06: Innovative applications/integration of geothermal heating and cooling in industry

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- High integration of geothermal heating and/or cooling in different industry sectors with operation flexibility considering start-up time and ramp-up rate, and maximum cascaded use of thermal energy.
- Increased industry, region, city and citizen trust and acceptability for geothermal energy.

Scope: Based on geothermal energy, the following is expected to be achieved: explore new heating and/or cooling concepts for industrial sectors which have to decarbonise their production lines using renewable systems. enable the smart use of thermal grids with emphasis on flexible supply of resources, adapted to different source temperatures and varying demand; and position geothermal utilisation (including underground storage) as a crucial pillar for the (heat and/or cold) transition of industrial energy systems. Projects should consider the application of cascading residual geothermal waste heat to neighbouring industries or the built environment and should include the integration of geothermal and heat pump systems, energy piles, or energy sheet pile walls, consider the use of alternative cycle working media.

Activities related to geothermal heat for industry and agriculture, underground thermal energy storage (UTES) including high-temperature storage, innovative and multiple uses for geothermal energy and side-products, balneological systems, and design and operation of geothermal doublets can be considered.

Activities are required to assess the environmental sustainability of geothermal heating and/or cooling applications. The applied technologies should not significantly harm the environment (Do No Significant Harm principle). It must be ensured that negative impacts on ecosystems and biodiversity, including negative impacts on (or pollution affecting) air, water or soil quality, are addressed through mitigation policies.

HORIZON-CL5-2024-D3-01-07: Development of hydropower equipment for improving techno-economic efficiency and equipment resilience in refurbishment situations

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to at all of the following expected outcomes:

- Keeping the availability of the existing hydropower fleet with an important role in the future power market as flexible power suppliers.
- Increase technology leadership, competitiveness and technology export potential of European hydropower industry.
- Reduced cost and improved efficiency of refurbished hydropower installations.
- Enhanced sustainability of refurbished hydropower, taking fully into account and balancing between circular economy, social, economic and environmental aspects in line with the European Green Deal priorities including energy and climate targets and biodiversity.

Scope: Development of hydropower equipment for improving techno-economic efficiency and equipment resilience in refurbishment situations of existing hydropower plants, which are outdated in respect of efficiency, power market interfacing, climate change adaptation and environmental sustainability, in particular also in respect of biodiversity. In scope are novel technologies, which improve the efficiency and economic parameters of existing hydropower plants during refurbishment without requiring substantial modification of the hydraulic system and by implementing circularity by design, e.g., low-friction and resistant materials

and technical solutions that can minimize tear and wear in future operation modes. Solution should positively affect CAPEX and OPEX per kWh and also be compliant with improving the water quality of the underlying water body and in particular positively affect biodiversity. Socio-economic and environmental sustainability including SDGs, circular economy, social, economic and environmental aspects should be addressed on a life cycle basis.

HORIZON-CL5-2024-D3-01-08: Demonstration of sustainable wave energy farms

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 18.00 and 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 38.00 million.
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 8 by the end of the project – see General Annex B.

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

- De-risking wave energy technology development and increased bankability/insurability of wave energy.
- Increased availability and improved market confidence in the technology.
- Increased knowledge on positive and negative impacts of ocean energy on its environment and in the case of negative impacts to protected habitats and species proposals for necessary mitigation measures.
- Publicly available data collected from the demonstration/pilot structure including support structure.

Scope: Demonstration of sustainable wave energy pilot farms (minimum 2.0 MW installed capacity and at least 4 devices) in full operational conditions for long periods of time is essential to advance this sector. It is the way to bridge the gap from technology development

to market development while reducing costs, reducing risks and attracting investors for future commercial projects. The farms should be composed of several devices of the same type.

The wave energy farms have to be connected to the electricity grid. To focus on the technologies with the greatest chances of success, the single wave energy device to be used in the array deployment is expected to be satisfactorily demonstrated at full scale before, with limited changes to incorporate the learnings. Any change on the wave energy device may be incremental but should not involve fundamental changes to the device design or composition. The innovation component should mainly lie on the pilot farm systems and supporting industrial manufacturing activities that enable a cost-effective and high-performance pilot farm. Where established, stage-gate processes can help ensure that this approach is followed.

The project is expected to deploy a wave energy farm with a minimum capacity of 2 MW and operate the farm at least 2 years in the lifetime of the project. After the project it is expected that the farm will continue to be operated for at least 8 years. The project should develop and execute an effective operation and maintenance programme.

Proposals are expected to address also all the following for both the supporting infrastructure for the farm and for the individual devices themselves:

- Industrial design and manufacturing processes including set up of an industrial supply chain, circularity of (critical) raw materials, sustainability, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.

- Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Necessary mitigation measures should be integrated to protect habitats and species. Present an environmental monitoring plan to be implemented during the demonstration action. Environmental monitoring data should be open source and be shared with EMODNET and the IEA OES environmental task.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project., The project proposal is expected to present a clear and convincing pathway to obtaining necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. For this the use of other EU/national/regional support mechanisms can be considered. Independent experts will assess all deliverables and will advise for the go/no-go decision.

The exploitation plans should include preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan, financial model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Data from the pilot structures should be collected to understand the performance and behaviour of the structure and the surrounding environmental condition to optimise the concept and understand the environmental impact of wave energy harvesting.

The selected projects are expected to contribute to the BRIDGE initiative[188], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2024-D3-01-09: Africa-EU CO-FUND action

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Programme Co-fund 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).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is 50% of the eligible costs. Beneficiaries may provide financial support to third parties in the form of grants. Financial support provided by the participants to third parties is one of the primary activities of this action to allow the partnership to achieve its objectives. Therefore, the EUR 60 000 threshold provided for in Article 204 (a) of the Financial Regulation No 2018/1046 does not apply.

[188] https://www.h2020-bridge.eu/

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

- Strengthening of the joint EU-AU Climate Change and Sustainable Energy Collaborative Partnership efforts, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.
- Acceleration of the achievements of the African continent's targets of the Paris Agreement.
- Establishing technologies for a sustainable energy system that meets the needs of different parts of society, in different geographical locations (urban and rural) and different economic sectors.

Scope: Following the EU commitments under the Paris Agreement, Agenda 2030 on Sustainable Development and the post-Cotonou Agreement, the renewed objective to evolve current forms of cooperation into equal footing partnership between Africa and Europe, the current research and innovation cooperation between Europe and Africa in the field of renewable energy needs to be further strengthened and developed.

The action should contribute to the implementation of the strategic and joint research and innovation action roadmaps [189] 1] implemented under Pilar 1 of the project LEAP-RE, www.leap-re.eu. The range of activities supported are expected to address the broad range of elements and technologies identified in LEAP-RE, in particular its six multi-annual roadmaps and should include a well-balanced set of research projects, demonstration projects, and technology transfer projects. Inclusiveness of a broad range of MSs/ACs and African partners will be considered an asset.

The proposal should envisage clustering activities with other relevant on-going EU-funded projects for cross-projects co-operation, consultations and joint activities on cross-cutting issues. Synergy is also to be considered with the projects to be funded by the end of 2022 through the Joint Undertaking Clean Hydrogen topic HORIZON-JTI-CLEANH2-2022-05-05? "Research & Innovation co-operation with Africa on hydrogen". To this end, proposals should provide for a work package and/or task dedicated to clustering activities and earmark the appropriate resources accordingly. The clustering activities should also consider and implement a joint programme of activities focussed on communication (participation in joint meetings and communication events), dissemination and exploitation.

It is expected that the action will organise joint calls on an annual basis and will consider ample time for the implementation and closure of the co-funded projects.

The proposal should also provide support to the operation of the Climate Change and Sustainable Energy collaborative action of the AU-EU High Level Policy Dialogue on Science, Technology and Innovation.

189 The roadmaps are available here www.leap-re.eu/pillar-1/

HORIZON-CL5-2024-D3-01-10: Next generation of renewable energy technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 27.00 million.
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 3-4 by the end of the project – see General Annex B.

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

- Available breakthrough and game changing renewable energy technologies enabling a faster transition to a net-zero greenhouse gas emissions EU economy by 2050.
- Knowledge and scientific proofs of the technological feasibility of the concept including the environmental, social and economic benefits to contribute to R&I strategy and policy forecast.
- Establishing a solid long term dependable European innovation base.

Scope: The proposal is expected to address high-risk/high return technology developments for game changing renewable energy technologies. It could cover catalyst development, dedicated renewable energy storage systems, integration of renewable energy technologies into a single energy generation system, heating & cooling systems, fuels production systems, solar driven chemical processes, hybrid electricity generation solutions between different renewable energy sources, direct utilization of renewable energy sources.

The following areas are excluded from the scope of the topic as they fall within the scope of partnerships or other calls:

- Hydrogen production through electrolysers.
- Fuel cells.

- Material research is covered under cluster 4 topics.
- Batteries as being covered in Destination 2.

The proposal is expected to validate its concept to TRL 3 or TRL 4 through a robust research methodology and activities. It should establish the technological feasibility of its concept, consider transfer developments in sectors other than energy whenever relevant, as they may provide ideas, experiences, technology contributions, knowledge, new approaches, innovative adapted materials for energy and skills.

Whenever the direct use of biogenic waste is considered, it will be taken into account from the design stage.

In developing its concept, the proposal is expected to address the following related aspects: lower environmental impact, minimising the impacts on biodiversity and protected species and habitats, better resource efficiency (materials, geographical footprints, water, etc…), issues related to social acceptability or resistance to new energy technologies, related socioeconomic and livelihood issues. Comparison with current commercial renewable energy technologies and/or solutions is expected. Impacts will be assessed through a quantified based Life Cycle Analysis. Considerations should be given to the regulatory frameworks for their adequate integration.

Energy systems, grids & storage

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-01-11: AI Testing and Experimentation Facility (TEF) for the energy sector – bringing technology to the market

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
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.

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

- Large-scale reference testing and experimentation facilities (TEFs) will offer a combination of physical and virtual facilities, in which technology providers can get support to test their latest AI-based software and hardware technologies in operational environments.
- This will include support for full integration, testing and experimentation of latest AI-based technologies to solve issues/improve solutions in the **energy sector**, at national as well as at local level, including validation and demonstration.
- The TEF is open to all the sites in Europe and equipped with the right equipment (Infrastructure, computing capacity & latest AI innovations).
- The TEF is a "long term investment". There should be a business model to guarantee self-sustainability.

Scope: The TEF is a technology infrastructure that has specific expertise and experience with testing in real conditions in the energy sector. They should build on existing infrastructures, facilities.

TEF should become common resources open to all the players, especially end users who should closely be involved. TEFs seek to support technology providers, but we also expect TEFs to include end-users of the technologies to ensure co-creation (in particular end-users can be involved in defining testing scenarios, protocols and metrics.

The TEF has the scope to then bridge the gap between lab and market due to lack of in-depth testing of AI technology in the real environment to fully validate them before the deployment.

Energy AI TEF will aim at testing AI–based technologies and solutions that have already been tested in the labs and have to be tested in operational environments.

Energy AI TEF will aim at optimising the deployment of AI-based solutions for a greener, smarter, more resilient, and more flexible energy system. For instance, it can investigate, how electricity grids respond to stimuli or shocks (e.g. RES integration, cyber-attacks, micro-grids development), making use of digital twins of the electricity grid at local level. Energy AI TEF can also target distribution grid optimisation, integrating both (decentralised) supply and demand-side, taking into account energy data coming from buildings, local storage, DER, electrical vehicles

TEFs can also support regulatory sandboxes by setting up a dialogue with competent national authorities for supervised testing and experimentation under real or close to real conditions.

The TEF can also support the development of new standards and ontologies for AI-Software for energy sector and common interoperability framework.

Energy AI TEF should give regions a further boost in attracting funding to upgrade its facilities and also attracting innovative players to collaborate with its own champions. In addition, TEF will contribute to more trustworthy AI made in Europe.

HORIZON-CL5-2024-D3-01-12: Energy Management Systems for flexibility services

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Contribute to the use of smart buildings and smart industrial sites for the integration of renewables in the energy system in an efficient way.
- Demonstrate aggregation of multiple (building or industrial) energy management systems to provide flexibility services (wholesale market price signals, demand response, flexible production, smart charging, balancing & frequency services, congestion management) to the electricity network.
- Demonstrate interoperability and data exchange technologies to aggregate data from different sources and in different formats through cooperation between aggregators and energy management system developers.
- Piloting and demonstration of flexibility pool operations at the local and regional levels.

The selected projects should propose recommendations how current products, markets and market processes for flexibility should be adapted to accommodate these new services and/or fully benefit from the potential these improved energy management services will bring.

Scope: Projects are expected to:

- Develop solutions to aggregate flexibility from different (types of) energy consumers that use different energy management systems to develop interoperable solutions to optimise the energy management systems and valorise its flexibility in wholesale markets and for balancing and/or congestion management services).
- Define and demonstrate the type of flexibility services that clusters of smart buildings and smart industrial sites can provide.
- Cooperate with (one or more) TSOs and/or DSOs, preferably making use of day-to-day operational flexibility markets (i.e. not R&I projects or regulatory sandboxes).
- Include at least 3 different energy management systems in case of industry, or 5 in case of buildings, developed by different technology providers and that use different protocols/standards/proprietary solutions for the energy management system.
- Involve at least 3 different energy system management service companies in case of industry, or 5 in case of buildings.
- Include at least 2 aggregators to ensure that developed solutions are based on standards and to avoid proprietary solutions.
- Include at least 1 home appliances producer in case of buildings. To ensure interoperability and integration into the grid, specific demonstrators will make use of operational end-to-end architectures, digital platforms and other data exchange infrastructure for the energy system being developed under ongoing Horizon 2020, Horizon Europe as well as under other EU programs such as the Digital Europe Program. Preferably semantically interoperable interactions, as enabled by the ETSI SAREF ontologies, are used.

Design and demonstrate appropriate concepts for acquiring and activating flexibility (implicit and explicit) that allow to maximally benefit from the potential of these new services. The project should demonstrate or recommend how the coordination and cooperation between TSO and DSO has to be organized to adopt the different concepts for services, products and markets.

The selected projects are expected to contribute to the BRIDGE initiative [190], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant

[190] https://www.h2020-bridge.eu/

activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

HORIZON-CL5-2024-D3-01-13: DC and AC/DC hybrid transmission and distribution systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
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: Project results are expected to contribute to all the following outcomes:

- Demonstrated top-down electricity system orchestration of future pan-European AC / DC hybrid system architecture - including offshore grid and energy islands - at different voltage levels (HVDC, MVDC, LVDC) down to DC microgrids.
- Developed methodologies for operational planning and design of DC and AC / DC hybrid systems, considering all possible sources, loads and storage, from high-voltage transmission level to distribution-connected assets. This includes a cost benefit analysis for stability management options.
- Developed methodologies and requirements for interoperability among Multi Terminal, Multi-Vendor MVDC and LVDC systems.
- Demonstrated technologies to be applied to the energy system to address the gradual loss of inertia caused by the increasing penetration of Power Electronics Interfaced Generators (i.e., RES such as PV, Wind, etc.).
- Demonstrated DC transmission and distribution systems and technologies.
- Components and systems for smart substations.

- Close collaboration among the key grid stakeholders (non-exhaustive list: software developers, system manufacturers, TSOs, third-party system integrators, wind turbine manufacturers, offshore wind farm developers, PV plants, storage systems, etc.).

Scope: Projects are expected to implement the activities in (1) and the practical demonstration in (2) as described below:

1. R&I, methodologies and tools involving the activities in the three subtopics (A, B and C) listed below. These can be developed/complemented with others pertinent to each sub-topic.

A) DC – AC / DC hybrid system Design & Planning

a. Demonstration of software tools for transnational AC/DC hybrid power system planning and management to enable HVAC/HVDC/MVDC/LVDC hybrid systems, such as:

- integration of multi-terminal HVDC systems, both offshore and onshore and HVDC links embedded within the HVAC network as well as HVDC ties (inter-) connecting different control zones and synchronous areas (in full or in back-to-back schemes);

- representation and modelling of transmission and distribution grids as well as multi-energy vector integration (sector coupling) for long-term and for transient and dynamic analysis.

b. Demonstration of reliability and resilience methodologies to address security and adequacy issues and criteria via not only deterministic but also probabilistic (e.g., Monte-Carlo) methods.

c. Demonstration of developed methodologies and requirements for interoperability among Multi Terminal, Multi-Vendor MVDC and LVDC systems.

B) AC and DC Grid Forming Capability

- Functional requirements and demonstration of grid forming capability for hybrid HV AC/DC networks (e.g., offshore wind, HVDC transmission or multi-terminal HVDC grid, potentially associated with energy storage systems).

- Functional requirements and demonstration of grid forming capability for hybrid MV and LV AC/DC networks (grid connected and islanded operation with distributed energy sources).

- Functional requirements and validation procedure for testing grid-forming capabilities offered by HVDC, MVDC and LVDC systems.

C) DC Distribution & microgrids

- Modelling (steady state and transient models) for systems including different typology of RES, EVs, storage and loads (system architecture, voltage level, control, stability, protection, and storage integration).

- Planning and design of MVDC distribution grids as the intermediate layer between the HVDC and the AC or DC Low Voltage local distribution grid and loads.
- Functional requirements for the AC-DC converters, DC-DC converters, switchgear (including protection equipment) and cables based on the different typologies and power rating applications

2. Demonstration, test and validation of the activities developed in (1) in at least three pilots – one for each sub-topic (A, B and C) – in different EU Member States/Associated Countries.

International cooperation with countries of the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-01-14: Condition & Health Monitoring in Power Electronics (PE) - Wide Band Gap PE for the energy sector

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
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 5-6 by the end of the project – see General Annex B.

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

a. Condition and Health Monitoring:

- Capability to anticipate failures of Power Electronics (PE) in wind farms and converters of the DC grid to prevent downtime.
- Techniques to set the equipment in limp mode to enable to withstand the stress until next maintenance.
- Demonstration of Condition and Health Monitoring (C&HM) for converters of wind turbines generators and HVDC converter stations or MVDC converters (solar energy).

b. Wide Band Gap and Ultra-Wide Bandgap PE:

- Development of new semiconductor power device technologies, in particular Wide Bandgap (WBG) and ultra-wide Bandgap (UWBG) semiconductors
- Availability of more efficient Power Electronics components for the development of new generation of inverters, converters and other power equipment in the energy sector.
- Reduced space occupancy aiming mainly at offshore applications.
- Improved cost efficiency of power devices and semiconductor fabrication processes.

Scope: Projects are expected to implement both the activities in (1) and the practical demonstration (2) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to each sub-topic.

A. Condition and Health Monitoring (C&HM):

- Estimation of junction temperature Tj based on TSEPs (thermo-sensitive electrical parameters). Here especially big challenge present SiC MOSFETS and Schottky diodes because the TSEPs sensitivity is lower, non-linear and depends on the built technology. Further issues are calibration, circuit drift, influence of PWM and other.
- Development of new and evaluation/further development of already existing unconventional techniques to measure temperature and estimate degradation (such as for example, but not limited to, Kelvin connection or acoustic based methods).
- Development and evaluation of new or already existing techniques for generating the lifetime models based on big-data analysis and by utilisation of soft computing techniques.
- Combination of (big) data-driven and physics-of-failure driven approaches in C&HM.

B. Stress Steering:

- Successful business case realisation requires co-operation and communication between different partners:
- Manufacturers of power electronics components (for example to integrate sometimes-necessary sensors).
- System designer (to provide access to the data such as measured load cycles and general mission profiles).
- Companies responsible for operation and maintenance of the systems. Currently those companies are especially for offshore wind parks developing their own C&HM systems, which are operating, based on sometimes-scarce available data.

- Optimisation is possible when already initial products would be designed to obtain data/measurements needed in C&HM. For power electronics modules, the most valuable data seems to be Tj (junction temperature):
- Careful estimation of the costs of maintenance for specified applications (it seems they are currently underestimated).
- Investigation of different costs models (e.g., the final costs for C&HM can be absorbed by the producers especially when it is also responsible for maintenance, or it can be transferred to the final user whenever the final user can provide safer and more reliable service).

C. Wide Band Gap and Ultra-Wide Bandgap PE:

Improvement of WBG and UWBG semiconductors for integration in HVDC and MVDC components. Work should focus on improving wide bandgap semiconductor devices, packaging and their integration in converter submodules:

- Improved WBG and UWBG power devices with better performance metrics, e.g., lower conduction losses, higher blocking voltage, better surge current capability, higher switching frequencies and better short-circuit capability.
- Advanced control circuits for WBG and UWBG based bridges.
- Improved packages featuring high-voltage insulation, high temperature operation, robustness, and low eddy currents.
- New submodule topologies for HVDC converters and/or new converter topologies for MVDC converters with WBG and UWBG semiconductors and better performance metrics, e.g., reduced losses, higher reliability, lower volume / weight, less costs.
- Implementing WBG and UWBG semiconductor devices for DC protection devices, e.g., DC breakers.
- Improved cost efficiency of components based on WBG semiconductors.

2. Demonstration, test and validation of the activities developed in (1) (A, B and C) in at least two pilots (all activities A, B and C developed for each pilot) in different EU Member States/Associated Countries.

HORIZON-CL5-2024-D3-01-15: HVAC, HVDC and High-Power cable systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 5.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

	selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
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.
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). [191].

Expected Outcome: Project results are expected to contribute to at least three of the following outcomes:

- High Voltage (HV), Extra High Voltage (EHV) or High Power/superconducting cable systems, including dynamic AC – DC cables.
- Development of not only better performing, but also more environmentally friendly materials for cable and accessory insulation.
- Improved tools for remote monitoring, repair and maintenance of equipment.
- Assessment of the feasibility of new cable system technologies.
- Increased reliability of HVDC or High-Power cable systems, through improved cable accessory design and/or ageing studies and/or use of cable condition monitoring techniques.

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

- Reduced cost of HVDC or High-Power cables, which increases feasibility of implementation in smaller projects, reducing the visual impact and improves social acceptability compared to AC overhead lines.
- Reducing the environmental impact of HVDC or High-Power cable systems through use of component designs with smaller climate footprints such as gas-free accessories or through conversion and reuse of existing infrastructure to increase power transfer capacity.
- When power demand increases and the ampacity of the power line is reached, the replacement of HVAC overhead lines with HVDC or with High-Power cable systems can avoid building new lines or reinforcing the grid.
- Increased power transfer over the same corridor and same or smaller right of ways.
- Methodology development of the OHL conversion from AC to DC with minimal line outage
- Contribution to the emergence of standards for DC OHLs in Europe
- Benefits of power dense technology options and avoidance of grid reinforcement.

Scope: Projects are expected to implement at least three of the activities in (1) for one or more subtopics (A, B, C) or (2) for one or more subtopics (D, E, F) and the practical validation in (3) as described below:

1. R&I, methodologies and tools involving the activities listed below. These can be developed/complemented with others pertinent to the topic.

A. Innovation in cable systems

- Development of new insulating materials for dry type accessories for high temperature and above 525 kV
- Optimisation of newly developed high electrical resistivity insulating materials for use above 525 kV in cable and/or accessories.
- Development of new network components with reduced environmental impact such as EHV/HV cables without lead, application of superconductors, AC, DC cables/gas insulated lines for voltages above 525 kV.
- Development of larger conductor cross sections.
- Development of smaller conductor cross sections and leveraging higher current superconductors - greater power density benefits.
- Increase of maximum insulation operating temperature, such as for high load urban areas where available space for power transfer is limited.

- Further improvement of different types of extruded insulation materials (e.g., AC, DC-XLPE, Polypropylene) cables, and render recyclability of the materials feasible by refining the procedure of separation of the many components of the cable – insulation, wires, tapes, sheaths, etc. – from each other. Establishment of procedures for recycling and related possible products.

- Feasibility study for use of superconducting cables for submarine connections to determine their environmental benefits e.g., extremely low heat emittance, since they do not emit any heat, zero magnetic field benefits to marine fauna, smaller cable corridors for higher power densities, smaller landfall space requirements, etc.

- Simulation and design of innovative dynamic cable systems to meet the needs of the growing floating offshore applications.

B. Predictive models for cable system ageing (fraction-of-life lost, remaining life), life and reliability

- Modelling of space charge phenomena (as well as other relevant phenomena) in newly developed insulating materials, in full size cables and accessories.

- Modelling of its effects on cable system aging taking advantage of advanced experimental space charge measurement techniques.

- AI methods for managing a cable fleet angle.

- Impact of water absorption on ageing of lead-free wet-design HVDC or High-Power cables.

- Ageing of cable systems, including effect of contaminants, humidity and temperature, and its implications for space charge accumulation and lifetime estimations. Test methods to quantify ageing in a DC environment, such as voltage form for DC-specific breakdown testing.

C. Monitoring and fault location systems

- Continuous temperature and acoustic monitoring of long cable system lengths.

- Accurate and instantaneous fault location systems for long cable system lengths.

- Further development and improvement of on- and off-line diagnostics and condition monitoring techniques for HVDC or High-Power cable systems such as PD and leakage current measurements for online and space charge and dielectric permittivity and loss factor measurements for offline.

- Innovative technological solutions such as fibre-based and/or robotic technologies for data collection and maintenance in in all type of location (easy-to-access and inhospitable).

- Development of procedures for optimised maintenance and repair concepts of offshore stations using BIM and 3D-Models.

2. Investigation and development of potential replacement of HVAC overhead lines with HVDC or High-Power cable solutions to increase capacity transfer without the need of building new infrastructures but reusing existing right of ways.

D. Cost-Benefit Analysis for different options of HVAC OHL conversion

- Mapping of the potential use cases for replacement of HVAC with HVDC or High-Power solutions (buried or overhead) supported by a Cost-Benefit Analysis.
- Cost-Benefit Analysis for conversion of HVAC OHL to HVDC, High Power OHL or buried High-Power cable solutions.
- Resilience and reliability analysis of different HVAC OHL conversion options – underground cable, HVDC OHL and buried High-Power cable solutions.

E. Technical innovations and design methodologies of hybrid HV AC/DC overhead lines

- Insulation coordination and clearances calculation methodologies, for HVDC and hybrid HV AC/DC overhead lines.
- Electrical field and ion current density calculation methodology under hybrid HV AC/DC OHLs ion flow field.
- Operation, control and protection of hybrid AC/DC overhead lines.
- Management of long-distance mixed cable and OHL HV corridors.

F. Pan-European grid studies and unification of voltage level of the converted OHLs from HVAC to HVDC

- Proposal of a unified DC voltage level of the converted lines considering the standard towers and line designs of HVAC OHLs (220 kV, 400kV) in the European network to provide a general conversion approach, compatible with minimum operation downtime.
- Perform pan-European grid studies to propose a unified strategy toward an overlaying HVDC grid based on the converted HVAC OHLs and existing corridors with minimized environmental impact, link downtime and implementation time.
- Dynamic grid studies to demonstrate the impact of the HVAC OHL conversion to HVDC.
- Develop identification criteria for the candidate HVAC OHL corridors (to be converted in HVDC).

3. Test and validation of the activities developed in (1) consisting of at least one of the activities described in each subtopic A, B, C or (2) consisting of at least one of the activities

described in each subtopic D, E, F in at least two validation tests in different EU Member States/Associated Countries.

HORIZON-CL5-2024-D3-01-16: Demonstration of innovative pumped storage equipment and tools in combination with innovative storage management systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Increased availability of innovative hydropower storage, in combination with innovative storage management systems.
- Maintain and increase technology leadership, competitiveness and technology export potential of European hydropower storage technology industry.
- Enhanced sustainability of innovative hydropower storage technologies, taking fully into account circular economy, social, economic and environmental aspects in line with the European Green Deal priorities.
- Reduced cost and improved efficiency of hydropower storage installations and the underlying technologies.

Scope: Demonstration of innovative pumped storage equipment and digital tools linking the mechanical storage with innovative storage management systems. The latter may involve hybridisation with storage technologies to reap the full potential of pumped hydro storage under new market conditions Solutions should deliver innovative hydropower technologies

adapted to unconventional storage schemes, including e.g. low-head locations or former coal mines and/or harsher operation conditions, e.g. using salt water, while minimising CAPEX, OPEX and improving life time and circularity of components. For the storage management system, digital tools for strategic and operational management should address current developments for energy storage, considering markets, variable renewable production and effects of climate change, and including novel approaches to energy. Demonstrated storage solutions should respond to the highest standards of environmental sustainability which is underpinned by a LCA and involve Citizens and Communities during all phases of the project activities, respectively. An analysis of innovative storage potential and impact should be performed.

Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate. The exploitation plans should include preliminary feasibility study and business plan also indicating the possible funding sources to be potentially used (such as private equity, InvestEU, EU Catalyst Partnership and the Innovation Fund).

HORIZON-CL5-2024-D3-01-17: Development and integration of advanced software tools in SCADA systems for High, Medium and Low voltage AC/DC hybrid systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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.

Expected Outcome: Project results are expected to contribute to at least three of the following outcomes:

- Optimised connection between power system design, preoperational planning and real-time monitoring and control.

- Measures and strategies for stability management of the future HVDC/MTDC power system connecting renewable energies (more specifically onshore wind farm).
- Measures and strategies for stability management of the future AC/DC hybrid power system with a high share of Power Electronic Interfaced Devices (PEID).
- Real-time capable algorithms and tools that enables optimal operation of the hybrid AC/DC system (e.g., avoidance of circular flows) and to support security analyses.
- Innovative ancillary services (e.g., frequency control, mitigation of periodic frequency fluctuations, voltage regulation and reactive power control).
- The possibilities offered by fast DC control in terms of islanding, black-start capability, firewalling for fault impact minimisation/avoidance, support for fault identification and return to safe, normal operation.
- Increased security of supply through firewalling cascading effects due to faults or cyberattacks by segmentation of the grid with a DC link.

Scope: Projects are expected to implement the activities in (1), the practical demonstration (2) and the recommendations for grid codes (3) for a realistic use case, at one or two voltage levels or at system level including all three voltage levels as described below:

1. Development of methodologies, technologies, algorithms and software tools, involving at least three of the activities listed below.
    - Development of innovative technologies, algorithms and analysis modules for multi terminal HVDC system – Software tools for analysing stability compatibility between DC and AC power system (e.g., Grid forming Vs. DC voltage stability)
    - Development of innovative algorithms and software tools for analysing and controlling the system of mixed, hybrid AC/DC grids. Integration of these tools into the control room software.
    - Scalable and flexible software framework for operation of hybrid AC/DC power systems supporting various vendor-dependent systems and component models, e.g., more accurate and wider representation of connected systems, power flow calculations.
    - Vendor independent hybrid DC/AC network SCADA/Energy Management System and upper-level control of voltage source converters (multi-vendor, multi-terminal), including changing active power set points, voltage/reactive power control set points and changing controller parameters.
    - Development and management of small signal and dynamic stability in a hybrid AC/DC power system with high penetration of inverter-based resources.

- Development of a robust online real-time estimation and calculation of the system state of the AC, DC and hybrid system.
- Development of safety and reliability analysis of the system state, analysis of possible failure situations as well as curative measures for the failure event, e.g., transient and dynamic stability, coordinated risk management.
- Development and integration of cyber secure resilient ICT platforms and communication for data exchange.
- Development of a DC link for firewalling the grid from cascading effects due to faults or cyberattacks.

2. Demonstration, test and validation of the activities developed in (1) for a fully automated decision support system for control centres in at least two pilots in different EU Member States/Associated Countries.
3. Recommendations for changes in grid codes, which can facilitate the deployment of the technology and ensure the full exploitation of the assets.

Call - Sustainable, secure and competitive energy supply

HORIZON-CL5-2024-D3-02

Conditions for the Call

Indicative budget(s)[192]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[193]	Indicative number of projects expected to be funded
		2024		
Opening: 17 Sep 2024 Deadline(s): 21 Jan 2025				
HORIZON-CL5-2024-D3-02-01	IA	6.00	Around 3.00	2

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

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

HORIZON-CL5-2024-D3-02-02	RIA	12.00	Around 4.00	3
HORIZON-CL5-2024-D3-02-03	RIA	7.00	Around 3.50	2
HORIZON-CL5-2024-D3-02-04	RIA	8.00	Around 4.00	2
HORIZON-CL5-2024-D3-02-05	IA	14.00	Around 7.00	2
HORIZON-CL5-2024-D3-02-06	IA	10.00	Around 5.00	2
HORIZON-CL5-2024-D3-02-07	CSA	3.00	Around 3.00	1
HORIZON-CL5-2024-D3-02-08	RIA	10.00	Around 5.00	2
HORIZON-CL5-2024-D3-02-09	IA	30.00	Around 15.00	2
HORIZON-CL5-2024-D3-02-10	CSA	8.00	Around 2.00	4
HORIZON-CL5-2024-D3-02-11	IA	15.00	Around 7.00	2
HORIZON-CL5-2024-D3-02-12	IA	15.00	5.00 to 7.00	3
Overall indicative budget		138.00		

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

Global leadership in renewable energy

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-02-01: Digital tools for CSP and solar thermal plants

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
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.
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.
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). [194].

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

- Improved performance of concentrated solar power (CSP) plants.
- Improved performance of concentrated and/or non-concentrated solar thermal heat and/or cold plants.
- Reduced operation and maintenance costs of CSP plants.
- Reduced operation and maintenance costs of concentrated and/or non-concentrated solar thermal heat and/or cold plants.
- Reinforced role of CSP plants in the power market.
- Reduced greenhouse gas emissions.
- Achievement of the CSP targets of the Strategic Energy Technology Plan.

Scope: Support will be given to the innovative application of digital tools (or to the application of innovative digital tools, or both) in CSP and/or concentrated solar thermal heat and/or cold and/or non-concentrated solar thermal heat and/or cold plants. Any type of application of the digital tools is in the scope (e.g., component control, performance measurement, self-diagnostic, ancillary services to the power system, digital twins, etc.). Artificial intelligence techniques are also in the scope.

Proposals are expected to bring and demonstrate measurable benefits of the proposed digital tools in terms of operation, maintenance, and flexibility of the plant.

Where applicable, the digital tools should support night baseload generation from thermal energy storage.

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

HORIZON-CL5-2024-D3-02-02: Development of next generation synthetic renewable fuel technologies

Specific conditions	
Expected EU	The Commission estimates that an EU contribution of around EUR 4.00

[194] 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

contribution per project	million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
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 3-4 by the end of the project – see General Annex B.

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

- Increase availability of disruptive emerging synthetic renewable fuel technologies.
- Accelerate the readiness of cost-effective and highly performing future technologies of synthetic renewable fuels for all economy sectors.
- Reinforce the European scientific basis and European technology export potential for synthetic renewable fuel technologies.

Scope: Development of next generation technologies for the production of novel synthetic renewable liquid and gaseous fuels from CO2, and/or renewable carbon, nitrogen, hydrogen or their compounds and from renewable energy. Process energy will also be renewable. Synergies with other renewable energy technologies can be explored. Focus should be on the high source to product conversion efficiency, process energy efficiency and carbon emission neutrality from the overall production. Overall, proposals are expected to improve competitiveness and minimize GHG emissions in the production process. Pathways via production of renewable hydrogen or renewable hydrogen ionic compounds from all forms and origins of renewable energy (e.g., electricity, direct sunlight, heat) are in scope. The new technologies should also address uses in fuel cells for all transport modes for electricity generation from renewable fuels used as renewable energy carriers with high conversion efficiency and low pollution. An assessment of the sustainability and the GHG emissions should be made based on a Life Cycle Analysis.

Projects should collaborate if appropriate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

HORIZON-CL5-2024-D3-02-03: Development of smart concepts of integrated energy driven bio-refineries for co-production of advanced biofuels, bio-chemicals and biomaterials

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 7.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Expand the portfolio of cost-effective advanced biofuel production concepts through energy-driven biorefineries.
- Reduce cost, improve efficiency, support de-risking, to accelerate the availability of competitive and zero-waste advanced biofuel production concepts.
- Contribute to the Mission Innovation 2.0 mission of Integrated Biorefineries.
- Optimize resource efficiency, energy output and total products value from biomass
- Reinforce the European scientific basis and European export potential for renewable fuel production solutions through international collaborations.

Scope: Development of zero-waste and neutral or negative carbon emission energy-efficient biorefinery concepts for enabling the production of low-cost advanced biofuels through co-production of added value bio-based products and bioenergy. Conversion of biogenic wastes and residues as well as algae and aquatic biomass through chemical, biochemical, electrochemical, biological, thermochemical pathways or combinations of them in highly circular processes are in scope. The integration design is expected to include mass and energy

flows, addressing the process heat and power needs by the use of co-produced bio-heat and bio-power, capturing and reusing biogenic effluent gases and sequestering biogenic emissions, for example in the form of biochar as soil amendment, such as to maximize overall material and energy efficiencies. An assessment of the feedstock cost supply at regional and local level and improvement of feedstock mobilisation patterns including via enabling technologies, such as digitalisation, should be included. Socioeconomic and environmental sustainability including circular economy, social, economic and environmental aspects are expected to be assessed on a life-cycle analysis basis. The advanced biofuels cost should aim to be reduced at parity with marketed biofuel equivalents or in the absence of these competitive to the fossil fuel equivalents. Technology validated in relevant environment is required. International cooperation with Mission Innovation countries is expected. Proposals should provide information and assessment about the economic feasibility and the potential of scaling-up the technology at commercial scale as appropriate.

Synergies are possible with topic HORIZON-CL6-2023-ZEROPOLLUTION: Innovative technologies for zero pollution, zero-waste biorefineries (RIA) and respective cooperation activities are encouraged.

HORIZON-CL5-2024-D3-02-04: Critical technologies for the future ocean energy farms

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Increased performance of ocean energy technologies with the focus on sustainability, operation and maintenance of ocean energy devices.

- Improved knowledge on how to operate ocean energy devices, their availability, maintainability, reliability, survivability, and sustainability.

- Reduction of LCOE.

Scope: Projects are expected to address at least one of the following areas:

1. Components and systems used in ocean energy devices need to be resistant to corrosion and the heavy loads they are subject to. Develop new sustainable materials with improved fatigue, damping, stiffness, sustainability and bio-fouling management or other cost-reducing characteristics. Materials such as reinforced concrete, polymers, composites, and concrete-steel/composite-steel hybrids systems have demonstrated some advantages such as reduced costs. Demonstrating the potential benefits of these new sustainable materials in ocean energy converters, moorings and foundations whilst ensuring structural integrity, durability and circularity is required. Advance the design of sustainable tailored mooring and connection of electrical or other power transmission systems for floating or subsea wave and tidal devices. Advance combined mooring and electrical connectors or hydraulic power transmission to reduce component cost and number of connection operations, included in systems for sharing an anchor between devices in arrays. Develop novel systems for safe and quick connection/disconnection that do not require large vessels and/or diving teams.

2. Instrumentation for condition monitoring and predictive maintenance of ocean energy devices. Apply recent advances in condition and structural health monitoring from other sectors to ocean energy – particularly those currently developed for offshore wind. Apply latest sensor technology to existing ocean energy deployments. Document and share experience on sensors performance and reliability, and methods for adapting them to the harsh ocean energy environment. Improve transmission or storage of data collected from sensors, such as underwater data transmission.

3. Artificial Intelligence (AI) in ocean energy technology development. Develop or apply advanced simulation of ocean energy systems. Use of big data with analysis of data streams, application of big data methods and machine learning, including artificial intelligence, or digital twin models for the design, installation, operation and decommissioning of ocean energy devices.

Improvements in the discrete technology areas should be developed holistically – e.g. work on monitoring instrumentation should be consistent with work on moorings & connections. The innovative technologies should not significantly harm the environment (DNSH principle), and have low impact on ecosystem biodiversity and consider potential mitigation measures. The projects should by using the precautionary principle elaborate proposals for acceptable harm and what low impact on biodiversity mean.

It is expected that key performance indicators are used based on international recognized metrics

Projects should demonstrate how improvements in the different technology topics can be applied to multiple different ocean energy devices – for example to a wide range of floating devices, or a wide range of sub-sea devices.

HORIZON-CL5-2024-D3-02-05: PV-integrated electric mobility applications

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The Joint Research Centre (JRC) may participate as member of the consortium selected for funding. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Photovoltaic power generation is pivotal to a clean energy system and the achievement of the net zero-emissions target. To this end, it is important to enhance affordability, sustainability and exploit the modularity and synergies of application of PV technologies.

Consequently, project results are expected to contribute to all of the following expected outcomes:

1. Open new market opportunities for Vehicle-Integrated Photovoltaics (VIPV) in road transport.
2. Reduce usage of the electricity grid and increase the range of electric vehicles.
3. Cost and energy efficient climate-neutral road transport.

Scope: PV technology can contribute to improved features of electric mobility systems not just in terms of CO2 (and air-pollution) emissions reduction but also regarding product aesthetics and user experiences. Proposals are expected to:

1. Demonstrate Vehicle Integrated PV concepts (VIPV),

a. Including different cell, interconnection and encapsulation technologies (with high efficiency under lower and varying lighting conditions) having a flexible design (size, shape/curvature, lightweight, aesthetics) and antifouling property, with PV providing a significant part of the vehicle's energy consumption under various climatic conditions.

b. Considering cost optimisation and environmental friendliness of VIPV integration that meets automotive specifications and safety/repair/maintenance standards (crash, emergency, resistance, reliability, long-lasting lifetime and high number of lifecycles) for various types and vehicle uses (including the provision of grid services);

c. With a vehicle usage model that maximises the ratio of using solar power and performance for VIPV, considering various light intensity variations, climatic conditions and uses while minimising energy losses.

d. Involving multidisciplinary consortia including at least one vehicle manufacturer.

2. Demonstrate PV Charging Stations (EVs, electric buses, etc.) able to provide a significant part of the charging demand despite the PV intermittence, guarantee the balance of the public grid, and reduce the public grid energy cost, with optimal charging/discharging start time for EVs, through its arrival time, departure time, initial and final state of charge (SOC), to achieve peak shaving, valley filling and other types of grid services, while reducing the costs of energy from the public grid.

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

Applicants can seek possibilities of involving the EC JRC. The JRC may provide characterisation, validation and certification of the performance of photovoltaic solar devices. It may also perform pre-normative research to develop appropriate characterisation methods for such devices as a precursor to the adoption of international standards as well as addressing stability, lifetime and environmental issues. This task shall be performed within the European Solar Test Installation (ESTI) an accredited ISO17025 calibration laboratory for all photovoltaic technologies.

HORIZON-CL5-2024-D3-02-06: Innovative, Community-Integrated PV systems

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
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: PV is growing fast, from domestic and commercial, up to utility scale systems. In the years ahead PV systems and solutions will be an integral contributor of distributed generation, pivotal in building functional energy communities, aggregated and operated through advance distributed controls in hierarchical set up with the integrated grid. Project results are expected to contribute to all of the following expected outcomes:

- Increase the profitability and penetration of PV systems in renewable energy communities.
- Engage actively citizens and communities in the clean energy transition in particular through the uptake of energy cooperatives and the development of decentralized platforms.

Scope: Proposals are expected to demonstrate a community-aggregated system with a portfolio of producers and users to facilitate the energy transition to a low carbon economy. Through this approach solutions can effectively address the need for overcoming energy poverty, support energy democracy, and expand cooperative solutions for the collective benefit of providers and users. Peer to peer trading and use can be made feasible and emerging solutions highly attractive and implementable.

- Planning, plant optimisation tools, advanced installation criteria, construction issues to increase yield and thus economic performance of PV systems in the built environment.
- Implementation of collective self-consumption schemes, design, simulation, integration with storage, interaction with electric mobility and interaction with the electrical grid to provide power flexibility.
- Effective protocols and robust communication and cooperation between the various required levels of control that is cyber secure, offering the benefits of advanced smart power electronics, sensors and intelligent systems.

This topic requires the effective contribution of Social Science and Humanities (SSH) disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities. Social innovations should also be considered, notably as new tools, ideas and methods leading to active citizen engagement and as drivers of social change, social ownership, and new social practices.

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-02-07: Resource Efficiency of PV in Production, Use and Disposal

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Coordination and Support 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).
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). [195].

Expected Outcome: Photovoltaic power generation is pivotal in the transition to a clean energy system and the achievement of a climate-neutral economy. To this end, it is important

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

to enhance its sustainability while creating wealth and additional employment opportunities in Europe.

Consequently, project results are expected to contribute to all of the following outcomes:

- Reduce the environmental footprint associated to PV technology deployment across all the phases of the system lifetime (production, transport, installation and end of life).
- Define design and processing guidelines to optimally address circularity of PV systems for one or several PV technologies (silicon, thin film, organic PV, perovskite PV, etc.).

Scope: In order to identify the main areas of improvement for the environmental footprint and resource efficiency of PV, it is necessary to regard the technology's entire lifecycle. Using Life Cycle Assessment (LCA), important knowledge can be gained as to which processes and materials contribute most to the overall environmental footprint. The lifecycle-thinking also aids in identifying key candidates to reduce the use of resources from the design phase. Although it seems self-explanatory that reduction/substitution or efficient use of critical materials lead to improved environmental impact, it is of course essential that these do not adversely affect the function of the technology.

For a renewable energy technology to be successful, it needs to have a strong net positive energy balance. This implies that the energy payback time of systems needs to be short, the carbon footprint needs to be reduced, the use of local materials to reduce transport costs in systems needs to be increased, the use of hazardous materials needs to be avoided, and systems and system components need to be designed in a way that encourages recycling and decreases material usage.

Modern eco-friendly technologies and long lasting, repairable products are required in combination with sound circular economy approaches to process the huge stock of valuable resources at the end of life.

International cooperation with the Mediterranean Region is encouraged.

HORIZON-CL5-2024-D3-02-08: Minimisation of environmental, and optimisation of socio-economic impacts in the deployment, operation and decommissioning of offshore wind farms

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
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.
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). [196].

Expected Outcome: If the project is on the first action 1) than the project results are expected to contribute to at least three of the outcomes a), b), and c). If the project is on the second action 2) than the project results is expected to contribute at least two of the outcomes a), b) and d)

- Enhanced sustainability by addressing economic, social and environmental aspects (air pollution, waste management, health and safety, job opportunities, wildlife concerns, etc.) of offshore wind farms (a).
- Enhanced overall sustainability of large-scale production of offshore wind farms based on mainstreamed Life Cycle Analysis addressing social, economic and environmental aspects, as well as improved circularity of offshore wind turbines (b).
- Improved understanding on the negative and positive impacts of offshore wind farms throughout their lifetime (c).
- Innovative and cost-effective solutions for the construction and decommissioning of offshore wind farms aiming also the minimisation of the potential impacts to biodiversity and protected species and habitats (d).

Scope: The aim is to develop and promote the use of modelling tools and objective holistic assessment metrics for realistic in-depth analysis of (cumulative) impacts of wind installations on the environment and on local communities and to integrate these in design tools for the

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

deployment and decommissioning of offshore wind farms. It will be as well necessary to find innovative solutions to minimize the environmental impact during all stages of the life cycle of offshore wind farms but especially for the construction and decommissioning phase. An assessment framework for installations is needed with nature inclusive design options valuing 'created habitats' vs 'natural habitats'.

The actions are expected to address one of the following actions:

Action 1: develop design tools which can be used for the planning of offshore floating and fixed-bottom wind farms with the focus to minimize the overall life-cycle environmental impacts (noise, impact on seabed, visual effect, effects on marine life and other species) including floating turbines (e.g. the environmental impacts of fixing/anchoring techniques), reducing carbon footprint of the offshore wind plants across the life cycle, from construction to end of life and reduce the environmental impact in each consecutive step. The tool should make use of existing data of environmental impact studies and should be easy to customise considering different sea basin biodiversity characteristics and new available data. For that reason, a strong participation/commitment of industry players is required to ensure that inventory data from industry of the components is used in the analyses and validation of the tools. The action will deliver recommendations for implementable, simple and measurable criteria to assess at the tendering stage of future project, considering the sustainability and environmental (positive and negative) impacts of offshore wind farms.

Action 2) develop innovative and cost-effective solutions (innovative processes, planning processes, supply chains, materials for construction, ….) for all phases of the life cycle of offshore wind farms but especially for the installation, construction and decommissioning phase of offshore wind farms with the aim to reduce the environmental impact as much as possible in these stages of the life cycle of offshore wind farms.

In order to increase the integration of the design tools and the innovative solutions, it is important that consortia engage all different stakeholders like regulatory bodies, industry, governments and citizens.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to 'carry out an analysis of costs and impacts of the decommissioning of offshore installations, with a view to assessing whether, both for the dismantling of the existing installations and for future decommissioning activities, EU-wide legal requirements are needed to minimise environmental, safety, economic impacts'.

HORIZON-CL5-2024-D3-02-09: Demonstrations of innovative floating wind concepts

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
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: Project results are expected to contribute to all of the following expected outcomes:

- Increased knowledge about design, construction, assembly and operation and maintenance of floating wind farms.
- Improved overall constructability, reliability, installability, operability and maintainability of floating offshore wind systems.
- Demonstrated efficient, low-cost and sustainable emerging technologies for floating wind turbines; reduction of the LCoE.
- Reinforced European offshore wind turbine value chain and skills.
- Data for future optimisation of industry scale commissioning of the floater, mooring and anchor system.

Scope: The overall aim is to accelerate the cost-effective construction and deployment of floating wind farms, facilitating their rapid and sustainable deployment across Europe and lower their overall costs. Projects are expected to

1. Do the design optimisation of a full floating system, facilitate the execution of the project addressing space needs in ports, vessels, etc., supply chain development
2. Demonstrate innovative floating vertical or horizontal axis offshore wind energy platforms (4 MW or higher total capacity for horizontal and 2 MW or more for vertical axis) in real sea conditions for long periods of time (12-24 months), collect data for future improvement design of the concept, to accurate predict future floating wind energy production and providing valuable learnings regarding performance, reliability, availability, maintainability, survivability and environmental impact. The wind energy system should be grid connected.
3. Develop and implement pilot projects for floating wind by identifying the best existing practices and the remaining knowledge gaps.

Proposals are expected to address also industrial design and manufacturing processes, circularity of (critical) raw materials, scalability, installation methods, transport, operation & maintenance, supply chains and the related digital infrastructures.

Projects are requested to demonstrate the technologies at sea while respecting existing environmental regulatory framework. Present an environmental monitoring plan to be implemented during the demonstration action. Data on environmental monitoring have to be shared with EMODNET, the IEA Wind Task 34 on the Environmental Impact of Wind Energy Projects, IEA Wind Task 49 on Floating Offshore Wind and IEA OES Environmental Task 4.

The project has to include a clear go/no go moment ahead of entering the deployment phase. Before this go/no-go moment, the project has to deliver the detailed engineering plans, a techno-economic assessment, including key performance indicators based on international recognized metrics, a complete implementation plan and all needed permits for the deployment of the project and a plan to achieve certification by an independent certification body before the end of the action. The project proposal is expected to clearly demonstrate a proposed pathway to obtaining necessary permits for the demonstration actions and allow for appropriate timelines to achieve these. The project is expected also to demonstrate how it will get a financial close for the whole action. Independent experts will assess all deliverables and will advise for the go/no-go decision.

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

The selected projects are expected to contribute to the BRIDGE initiative [197], actively participate to its activities and allocate up to 2% of their budgets to that end. Additional contributions to the 'Alliance for Internet of Things Innovation' (AIOTI) and other relevant activities (e.g. clusters of digital projects and coordinating actions) might be considered, when relevant.

This R&I need is identified in the offshore renewable energy strategy (COM(2020) 741 final) that commits the Commission to 'develop new wind, ocean energy and solar floating technology designs, for example through Horizon Europe'.

HORIZON-CL5-2024-D3-02-10: Market Uptake Measures of renewable energy systems

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately.

[197] https://www.h2020-bridge.eu/

project	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
Type of Action	Coordination and Support 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).
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). [198].

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

- Facilitate the wider uptake of renewable energy systems (RES) in the energy, industrial and residential sectors leading to an increased share of renewable energy in the final energy consumption by 2030 and beyond.
- Contribute to provide open source validated tools and methodologies for policy makers and stakeholders for developing more informed RES policy and for analysing the market dynamics when including all renewable energies.
- Contribute to the development of markets and respective financial frameworks that can operate in an efficiently and incentive-compatible manner while accommodating massive shares of renewables.
- Improve social acceptability of renewable energy facilities and installations.

Scope: The proposal is expected to develop solutions addressing at least 2 of the expected outcomes either for the entire renewable energy market or focusing on a specific energy

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

sector, such as electricity, heating, cooling or renewable fuels. Proposals can also address issues within a specific geographical region such as urban and peri-urban areas. Issues related to acceptability of RES technologies due to ecologic, economic and social aspects are expected to be addressed. Self-consumption issues can be addressed too. International aspects, such as collaboration with third countries and promoting solution in new markets, can be addressed as well.

The proposed solution can be developed to address a local challenge but needs to have wide potential for reapplication. The solution is expected to have a long-term viability and not be limited to an ad-hoc fix. The methodologies applied may be inspired by successful approaches already tested in other fields or contexts.

For all actions, the consortia have to involve relevant stakeholders (e.g. businesses, public authorities, civil society organisations) and market actors who are committed to adopting/implementing the results. The complexity of these challenges and of the related market uptake barriers may call for multi-disciplinary approaches, which requires contributions from the social sciences and humanities. Where relevant, local, regional specificities, socio-economic, gender-related, spatial and environmental aspects will be considered from a life-cycle perspective.

Proposals are encouraged to address social acceptability through the assessment of the environmental economic and social impacts associated with the development of these renewable energies and through the adequate involvement of stakeholders in decision-making processes.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects for understanding and addressing societal barriers to the uptake of renewable energy systems.

Where relevant, proposals are expected to also assess the legal, institutional, and political frameworks at local, national and European level and examine how, why and under what conditions these could act as a barrier or an enabler.

Carbon Capture, Utilization and Storage (CCUS)

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D3-02-11: CCU for the production of fuels

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
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.
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). [199].

Expected Outcome: Conversion of captured CO2 is not only a means to replace fossil fuels, but also a promising solution for seasonal energy storage. There are still some scientific and technological challenges to overcome to be able to exploit CO2 as a fuel feedstock, the main challenge being that the utilisation of CO2 is limited by the highly energy intensive conversion process.

New solutions for the conversion of captured CO2 from different sources to fuels will create new markets for innovative industrial sectors and diversify the economic base in carbon-intensive regions, as well as contribute to achieving a Circular Economy. The project should evaluate the possibility for industrial CO2 use/reuse through the combination of processes (industrial symbiosis) and the efficient integration of CO2 capture and conversion to combine and/or reduce stages.

Scope: Proposals will aim at the development of energy-efficient and economically and environmentally viable CO2 conversion technologies, including energy storage and/or displacement of fossil fuels that allow for upscaling in the short to medium term. Proposals have to define ambitious but achievable targets for energy requirements of the conversion process (including catalytic conversion), production costs and product yields that will be used to monitor project implementation. Proposals have to include the potential for the proposed

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

CCU solution(s) as CO2 mitigation option through conducting an LCA (Life Cycle Assessment) in line with guidelines developed by the Commission, such as the Innovation Fund GHG methodology and the relevant ISO standards and the EU Taxonomy Regulation.

Technology development has to be balanced by an assessment of the societal readiness towards the proposed innovations. Relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) will be identified in the proposal, and involved in deliberative activities, so as understand and address their concerns and needs. This will be analysed during the project using appropriate techniques and methods from the social sciences and humanities, in order to create awareness, gain feedback on societal impact and advancing society's readiness for the proposed solutions. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities. Projects should also explore the socio-economic and political barriers to acceptability and awareness with a view to regulatory or policy initiatives and include aspects of circularity and best use of resources.

Proposals are expected to bring technologies that have reached at least TRL 4-5 to TRL 6-7 (please see part G of the General Annexes).

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

Projects are strongly encouraged to join the EU CCUS knowledge sharing project network.

Projects should collaborate if appropriate with the Clean Hydrogen Joint Undertaking on aspects that require integration of hydrogen and are expected to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

This topic is complementary to the call CL4- Destination 1 Energy Intensive Industries on CCU.

HORIZON-CL5-2024-D3-02-12: DACCS and BECCS for CO2 removal/negative emissions

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.

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: In order to ensure that a balanced portfolio of activities covering both DACCS and BECCS, the available budget will first be allocated to the proposal with the highest score, followed by the next highest-ranked proposal dealing with the technology that has not been covered by the proposal selected first.
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). [200].

Expected Outcome: The European Union aims at reducing its net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, and at achieving carbon neutrality by 2050. Under the European Green Deal, the Commission has also adopted a zero-pollution action plan, with a zero-pollution ambition, and a Biodiversity Strategy. In view of achieving these ambitious targets it is appropriate to further explore the development of direct air carbon capture and storage (DACCS) and bioenergy carbon capture and storage (BECCS) as CO2 capture technologies in combination with CO2 storage, duly assessing their impacts on other environmental challenges.

The project is expected to develop highly innovative CCUS /carbon negative technologies leading to CO2 removal. It should enable the cost-effective deployment of technologies such

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

as (DACCS), (BECCS) ideally linking them to industrial clusters with special emphasis of these technologies to safe CO2 underground storage and CO2 utilisation.

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

- Improve existing or develop new materials for DACCS and/or BECCS technologies; or
- Address potential barriers to the incorporation of DACCS and/or BECCS technologies in existing CC(U)(S) concepts; or
- Make DACCS and/or BECCS technologies a viable option to make the EU carbon neutral by increasing the TRL levels and reducing cost of the different technological options

Scope: This topic focusses on DACCS and BECCS, which are technologies that can help reaching climate neutrality by 2050 by creating the carbon sinks required to balance out residual emissions in 2050.

The scope of this topic is to further the technological development of DACCS and BECCS, and addressing the environmental, social and economic challenges and benefits with the view of establishing this concept as a viable technology to fight climate change. The potential technologies require major technological breakthroughs.

Projects have to substantiate the potential for the proposed solutions as CO2 mitigation option by conducting an LCA in conformity with guidelines developed by the Commission, such as the Innovation Fund GHG methodology and the relevant ISO standards and the EU Taxonomy Regulation. This life cycle consideration should include the sustainability of biomass and the renewable origin of electricity but also assess other environmental dimensions (requirements for land, water; impacts on air and water quality, biodiversity; distances to major storage clusters, leakages etc.).

Technology development has to be balanced by an assessment of the societal readiness towards the proposed innovations. Relevant end users and societal stakeholders (such as civil society organisations, non-governmental organisations, and local associations) will be identified in the proposal and involved in deliberative activities to understand and address their concerns and needs. This will be analysed during the project using appropriate techniques and methods from the social sciences and humanities, in order to create awareness, gain feedback on societal impact and advancing society’s readiness for the proposed solutions. Projects, therefore, could consider the inclusion of relevant SSH expertise in order to enhance the societal impact of the related research activities. Projects should also explore the socio-economic and political barriers to acceptability and awareness with a view to regulatory or policy initiatives and include aspects of circularity and best use of resources.

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

model) indicating the possible funding sources to be potentially used (in particular the Innovation Fund).

Proposals that include research into the use of direct air capture and BECCS for enhanced oil recovery will not be considered. Proposals are expected to take into account the related activities within the EU ETS Innovation Fund and the EU Catalyst Partnership. International cooperation with Mission Innovation countries is encouraged in line with the Carbon Dioxide Removal Mission (CDR Mission). [201].

Successful projects will be encouraged to join the EU CCUS knowledge sharing project network.

[201] Applicants are reminded that legal entities established in China are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.