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Annex 7

Horizon Europe
Work Programme 2021-2022

7. Digital, Industry and Space

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Introduction

Progress in digital and industrial technologies, including in space, shape all sectors of the economy and society. They transform the way industry develops, produces new products and services, and are central to any sustainable future. The COVID-19 crisis of 2020 has shown the necessity to strengthen Europe's industrial base, enhancing its resilience and flexibility both in terms of technologies and supply chains to reduce EU dependencies on third countries. It has also created a new urgency around addressing key societal challenges like sustainability or inclusiveness. In a globalised world of heightened uncertainties and volatile geopolitical interests, what is at stake is not only Europe's prosperity and economic competitiveness, but also its ability to autonomously source and provide crucial raw materials, technologies and services that are safe and secure for industry as a whole. This is not about protectionism. This is about upholding EU's strategic interests.

As Europe gears up for a more resilient, green, and digital recovery, the EU needs to maintain a strong industrial and technology presence in key parts of digital and other supply chains, in industrial ecosystems while safeguarding its ability to access and operate safely in space. This is critical not only to be able to compete globally, but also to protect its citizens, deliver services and products of the highest quality, and preserve its values and socio-economic model. To come out of the crisis faster, it will not only need to develop, but also deploy technologies and reshape its industries and services towards a new reality, ensuring that industry can become the accelerator and enabler of this change, as stated in the European Commission's 'New Industrial Strategy for Europe' supporting the Green Deal and announcing the Circular Economy Action Plan, digital strategies 'Shaping Europe's Digital Future', 'Data' 'Artificial Intelligence White Paper and 'Space Strategy for Europe' . To deliver on a green and digital transformation according to European values, Europe must master digital, space and key enabling technologies and reintegrate some of its supply chains into the EU. Increased adaptability and resilience to improve production response, recovery and preparedness will also include continuous investments in upskilling and reskilling of the work force.

The green transition and digital transformation are just at their beginning. Major opportunities lie ahead to position Europe as a technology and industrial leader of this transition. The overarching vision behind the proposed investments under Cluster 4 is that of Europe shaping competitive and trusted technologies for a European industry with global leadership in key areas, enabling production and consumption to respect the boundaries of our planet, and maximising the benefits for all parts of society in the variety of social, economic and territorial contexts in Europe.

Actions under this cluster will support key enabling technologies that are strategically important for Europe's industrial future, and deliver on the following six expected impacts in the Strategic Plan, through matching destinations in this Work Programme:

- Global leadership in clean and climate-neutral industrial value chains, circular economy and climate-neutral digital systems and infrastructures (networks, data centres), through

innovative production and manufacturing processes and their digitisation, new business models, sustainable-by-design advanced materials and technologies enabling the switch to decarbonisation in all major emitting industrial sectors, including green digital technologies.

- Industrial leadership and increased autonomy in key strategic value chains with security of supply in raw materials, achieved through breakthrough technologies in areas of industrial alliances, dynamic industrial innovation ecosystems and advanced solutions for substitution, resource and energy efficiency, effective reuse and recycling and clean primary production of raw materials, including critical raw materials and leadership in circular economy.
- Sovereignty in digital technologies and in future emerging enabling technologies by strengthening European capacities in key parts of digital and future supply chains, allowing agile responses to urgent needs, and by investing in early discovery and industrial uptake of new technologies.
- Globally attractive, secure and dynamic data-agile economy by developing and enabling the uptake of the next-generation computing and data technologies and infrastructures (including space infrastructure and data), enabling the European single market for data with the corresponding data spaces and a trustworthy artificial intelligence ecosystem.
- Strategic autonomy in conceiving, developing, deploying and using global space-based infrastructures, services, applications and data, including by reinforcing the EU's independent capacity to access space, securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector competitiveness.
- A human-centred and ethical development of digital and industrial technologies, through a two-way engagement in the development of technologies, empowering end-users and workers, and supporting social innovation.

DESTINATION 1 – CLIMATE NEUTRAL, CIRCULAR AND DIGITISED PRODUCTION

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- KSO C, ‘**Making Europe the first digitally led circular, climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems.’
- KSO A, ‘**Promoting an open strategic autonomy 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.’
- KSO D, ‘**Creating a more resilient, inclusive and democratic European society**, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.’

Proposals for topics under this Destination should set out a credible pathway to the following expected impact of Cluster 4:

- **Global leadership in clean and climate-neutral industrial value chains, circular economy and climate-neutral digital systems and infrastructures (networks, data centres)**, through innovative production and manufacturing processes and their digitisation, new business models, sustainable-by-design advanced materials and technologies enabling the switch to decarbonisation in all major emitting industrial sectors, including green digital technologies.

Accelerating the twin green and digital transitions will be key to building a lasting and prosperous growth, in line with the EU’s new growth strategy, the European Green Deal. Europe’s ability to lead the twin transitions will require new technologies, with investment and innovation to match. Research and innovation will be fundamental to create the new products, services and business models needed to sustain or enable EU industrial leadership and competitiveness, and to create new markets for climate neutral and circular products. The shift towards a sustainable and inclusive economic model will be further enabled by the broader diffusion and uptake of digital and clean technologies across key sectors.

As Europe transitions towards climate neutrality, some sectors will have to make bigger and more transformative changes than others, due to their centrality in a variety of value chains and their large potential contribution to emissions reductions. Activities under this Destination focus on the twin green and digital transition providing a green productivity premium to discrete manufacturing, construction and energy-intensive industries, including process industries. This will make an essential and significant contribution to achieving climate

neutrality in the European Union by 2050, and to the achievement of a circular economy. It will also enhance the Union's strategic autonomy with regard to the underlying technologies. To achieve these goals, the activities in this Destination are complementary to those in Destination 2, which will enhance strategic autonomy in key strategic value chains for a resilient industry.

The gross added value of the European manufacturing sector is EUR 2,076 billion (2019). The sector employs more than 30 million people in the Union and represents 22% of the world's manufacturing output. The Union's trade surplus in manufactured goods is EUR 421 billion (2019). Similarly, the construction sector (driven mainly by SMEs) offers 18 million jobs and contributes to 9% of the Union's GDP. However, the manufacturing and construction sectors must significantly reduce their pollution and waste, and increase their recycling. Moreover, the potential of digital technologies is underused in manufacturing industry, e.g. 12% of EU enterprises use big data technologies and only 1 out of 5 SMEs is highly digitised, and in construction, which remains one of the least digitised sectors with a notable underinvestment in R&D. A key issue for the manufacturing sector is that its complex supply and value chains are heavily affected by the current pandemic crisis, and the sector needs to further develop resilience against financial and technical disruptions.

In addition, the Union's process industry is hugely important to its economy, its resilience and its environmental credentials, but faces two key challenges: a strong global pressure (e.g. China, USA), and an environmental challenge. Energy-intensive industries, including process industries, are by nature resource intensive, using extensive amounts of raw materials, often imported fossil based ones. In their operations, they generate large amounts of waste, greenhouse gases (GHG) and pollutants. The sector needs to transform itself to decrease GHG and pollutant emissions, its resource utilisation and its overall environmental impact. It will have to achieve climate neutrality, near zero waste, zero pollution and zero landfill by 2050 at the latest.

In the first Work Programme, outcomes of R&I investments in the long-term will focus on the following impacts:

- Accelerate the twin green and digital transition of the manufacturing and construction sectors;
- Create a new green, flexible and digital way to build and produce goods. This will lead to sustainable, flexible, responsive and resilient factories and value chains, enabled by digitisation, AI, data sharing, advanced robotics and modularity. At the same time it will help reduce CO₂ emissions and waste in these sectors, and enhance the durability, reparability and re-cycling of products/components. It will also ensure better and more efficient use of construction-generated data to sustain competitiveness and greening of the sector;
- Make the jobs of the humans working in the manufacturing and construction sectors more attractive and safer, and point the way to opportunities for upskilling;

- Set out a credible pathway to contributing to climate neutral, circular and digitalised energy intensive industries;
- Increase productivity, innovation capacity, resilience, sustainability and global competitiveness of European energy intensive industries. This includes at least 10 new large hubs for circularity by 2025 (TRL 7 or above); developing sustainable ways for circular utilisation of waste streams and CO₂/CO streams; and electrifying industry to enable and foster a switch to a renewable energy system;
- Contribute to a substantial reduction of waste and CO₂ emissions, turning them into alternative feedstocks to replace fossil-based raw materials and decrease reliance on imports.

To achieve wider effects activities beyond R&I investments will be needed. Three co-programmed partnerships will enhance dissemination, community building and foster spillover effects: Made in Europe for the manufacturing sectors, Clean Steel and Processes4Planet for the energy intensive industries. This destination has strong links to other clusters in Pillar II, notably Cluster 5 for the activities related to the integration of renewables and thermal energy management in industry, and with the European Innovation Council and Pillar III of Horizon Europe given the strong role of SMEs in the development of the innovations planned. Synergies will be sought to access blended funding and finance from other EU programmes; testing and deployment activities under the Digital Europe Programme (DEP); links to the EIT (Manufacturing and Digital KICs); and links to the thematic smart specialisation platform on industrial modernisation.

The topics serving these objectives are structured as follows:

- Green, flexible and advanced manufacturing
- Advanced digital technologies for manufacturing
- A new way to build, accelerating disruptive change in construction
- Hubs for circularity, a stepping stone towards climate neutrality and circularity in industry
- Enabling circularity of resources in the process industries, including waste, water and CO₂/CO
- Integration of Renewables and Electrification in process industry

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

Call	Budgets (EUR million)Deadline(s)

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

HORIZON-CL4-2021-TWIN-TRANSITION-01	
HORIZON-CL4-2022-TWIN-TRANSITION-01	
Overall indicative budget	

DRAFT

Call - TWIN GREEN AND DIGITAL TRANSITION 2021

HORIZON-CL4-2021-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)¹

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ²	Number of projects expected to be funded
HORIZON-CL4-2021-TWIN-TRANSITION-01-02	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-03	RIA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-05	RIA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-07	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-08	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-10	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-11	RIA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-	IA	Around		

¹ 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 2021 and 2022.

² Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

01-12		N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-14	RIA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-15	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-16	CSA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-17	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-18	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-19	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-20	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-21	IA	Around N/A		
HORIZON-CL4-2021-TWIN-TRANSITION-01-22	IA	Around N/A		
Overall indicative budget				

General conditions relating to this call

<i>Documents</i>	The documents are described in General Annex E.
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Award criteria</i>	The criteria are described in General Annex D.
<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.
<i>Financial and operational capacity and</i>	The criteria are described in General Annex

<i>exclusion</i>	C.
<i>Procedure</i>	The procedure is described in General Annex F.

Green, flexible and advanced manufacturing

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-02: Zero-defect manufacturing towards zero-waste (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Demonstrate a significant increase of sustainable production through improved control systems and non-destructive inspection methods;
- Develop methodologies and tools to prevent the generation of defects at component level and its propagation to the system level;
- Create new diagnostic methods for in-situ monitoring of industrial production;
- Ensure efficient use of materials, repair strategies, and reduced production cost and time.

Scope: The projects must address the full production line or system, with an holistic approach, with the aim of reducing defects (e.g. rejected components or products) and manufacturing waste. The defect reduction and the overall quality control should be centred on such defects that reduce the yield, acceptance, or qualification of the final product, and enable a “first-time-right” production process.

Projects should target types of waste or discarded material from identified defective products or components that cannot be easily reworked or recycled without significant effort. This implies a demonstrable transition to a sustainable production, and should include additional elements such as life-cycle analyses and environmental assessments.

The system improvements should also contain two main elements:

- The integration of control systems and/or in-line non-destructive inspection methods in demonstrative use-cases that enable for rapid feedback and/or feedforward control;
- The use of large data sets and analysis, stemming from all sorts of production process and material data, also supported by data-sharing between sites, for the creation of comprehensive machine learning algorithms.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2021-TWIN-TRANSITION-01-03: Laser-based technologies for green manufacturing (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Reinforcing European industry as leader in agile, green manufacturing through the application of laser-based technologies;
- Improving the agility of industrial production by making processes more versatile, simpler to reconfigure and more efficient to control through data exchange;

- Improving the environmental sustainability of industrial production towards ‘first-time right’ processes with 30% lower consumption of resources compared to the state of the art.

Scope: Machine tools include various laser-based technologies such as milling, turning, grinding, laser processing, surface treatment, forming and additive manufacturing. Projects funded under this topic should integrate state-of-the-art high-power lasers and tailored beams together with quality sensors and real time monitoring systems into advanced manufacturing and re-manufacturing tools.

Known research challenges are amongst others the transmission of very high average and peak power laser radiation without loss or distortion including in the ultraviolet, mid and far infrared spectral range, powerful optical fibres, programmable beam guidance, maximum positional flexibility, free choice of energy distribution, rapid quantitative feedback and beam distribution systems with sub-micrometre resolution and high performance. A further research challenge is the integration of quality sensors in laser-based manufacturing. These produce a vast amount of data with a need for dedicated signal processing. Edge devices with self-learning algorithms should be developed that can handle the computing requirements.

Project consortia should comprise research institutes, technology suppliers and users. They should demonstrate the benefits to the targeted technologies in at least three use cases.

This topic implements the co-programmed European Partnership on Made in Europe and activities proposed by the Photonics Europe Partnership.

HORIZON-CL4-2021-TWIN-TRANSITION-01-05: Manufacturing technologies for bio-based materials (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Demonstrate large-scale production of innovative bio-based products to substitute traditional materials with high environmental footprint;
- Develop products with similar or better mechanical, physical and chemical properties, while having a substantially lower environmental footprint and being sustainable, non-toxic and recyclable;
- Demonstrate disruptive innovation of bio-based materials production in at least three different manufacturing value chains;
- Develop sustainable business models for materials sourcing and recycling.

Scope: The 2020 Circular Economy Action Plan aims at making sustainable products the norm in the EU. Twenty-first century manufacturing requires new materials and new techniques to produce them. Rapid progress in manufacturing technologies using new and alternative materials, such as biomaterials, is one of the drivers of this trend. This new frontier of science is a multidisciplinary research field combining engineering, physics, chemistry, biology, material science, which allow the production of bio-based products. Particularly interesting with respect to the green transition of the economy are sustainable products made from bio-based materials that are easy to reuse and recycle. Also, these materials would reduce the environmental footprint of waste streams. However, the use of recyclable bio-based materials should increase substantially in order to build a truly sustainable manufacturing industry.

These technologies provide a valid alternative to synthetic materials with a substantially lower environmental impact with a range of applications for example in construction, food, medical, packaging and textile industries.

Research activities should address the following areas:

- Optimisation and improvement of smart manufacturing processes, e.g. additive manufacturing, to unlock the full potential of bio-based materials, such as carbon-positive bioplastics, biopolymers and other fiber-based materials (e.g. cellulose-based components and marine-based components);
- Use of carbon positive bio-based materials, such as composite, rubber, plastics, in different products to achieve high technical properties while lowering the environmental footprint;
- Adapt existing or new characterisation methods and quality controls for the bio-based materials in different formats and for the obtained products;
- Support the creation of a skilled workforce, through training/qualification of personnel, capable of using and implementing biomaterial-based manufacturing activities;

- Demonstrations and use cases for transitions towards green manufacturing technologies incorporating bio-based materials with a significant reduction in the environmental footprint across the entire manufacturing and/or product lifecycle.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

This topic implements the co-programmed European Partnership on Made in Europe.

Advanced digital technologies for manufacturing

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-07: Artificial Intelligence for sustainable, agile manufacturing (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Establishing European industry as leader in sustainable manufacturing and process industries through the application of AI technologies;
- Improving the environmental, economic and social sustainability of industrial production;
- Improving the agility of European industry and its resiliency to external and internal influences;
- Improving human-machine collaboration, enhancing unique human abilities and making manufacturing jobs more attractive;

- Integrating state-of-the-art AI technologies with advanced manufacturing and re-manufacturing technologies and systems, exploiting their potential across the entire product lifecycle;
- Foster standardisation activities relevant to AI in Manufacturing.

Scope: This topic focuses on manufacturing and process industries, addressing the entire lifecycle of products and services from design to remanufacturing and including all the aspects primarily relevant for industrial production. The objective is to exploit the potential of AI as a transformation tool for the entire manufacturing and process industry with due consideration for standardisation activities when relevant. AI will be a strategic instrument to improve sustainability, agility and resilience to external and internal influences, taking account of the European Green Deal objectives. AI applications will be capable of optimising their actions based on limited human input, thanks to their awareness of the context and of the physical environment delivered by sensors, and will have the long useful lifetime typical of industrial environments.

Projects have to address the need for simplified AI tool sets for use in manufacturing environment without highly skilled personnel. Methods and tools to reduce the resources necessary for training of AI algorithms will be developed and improved for use also on lower volume production and shorter time series.

Generative approaches will help designing products and processes improving the sustainability of industrial solutions, and capable of quick evolution whenever the external conditions demand it. The topic will integrate new or existing technologies to make them practically and economically viable in the industrial world, e.g. by developing several use cases with demonstrated return on investments.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2021-TWIN-TRANSITION-01-08: Data-driven Distributed Industrial Environments (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Procedure</i>	The procedure is described in General Annex F. The following

	exceptions apply: To ensure a balanced portfolio covering all technology areas, grants will be awarded to applications not only in order of ranking but also to at least one project per technology area, provided that the applications attain all thresholds.
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 8 by the end of the project – see General Annex B.

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

- Establishing European industry as leader in sustainable data-driven manufacturing and process industries through efficient data processing, improving the environmental, economic and social sustainability of industrial production, and reinforcing European leadership in the deployment and operations of industrial network;
- Improving the agility of European manufacturing industry and increase its resiliency to external shocks, including with agile, secure and easy-to-implement non-public 5G systems, leading to more resilient production processes;
- Demonstrate the use of open systems available and qualified open source software tools for data monitoring & collection as well as data analytics;
- Foster industrial data and distributed computing standardisation;
- Facilitate the development of technologies requiring only minimal training of the industrial workforce.

Scope: Fully reaching the opportunities of sharing and exploiting industrial data, including deep industrial data, requires to strike the right balance between storing and handling data centrally in the cloud or locally at the edge of industrial network. Such a balance has to take into account not only efficiency but also the real-time requirements and cybersecurity aspects as well as the ability to systemically integrate and upgrade operational technology to the innovative developments in (self-) configuration, therefore building a flexible industrial Internet for distributed control and modular manufacturing while keeping the high-level of reliability and safety required by the manufacturing sector.

Computing, storage and networking technologies will have to show also flexibility along the industrial value chains and promote the introduction of new business models, based on the availability of deep industrial data from different data sources and ontologies, within an agreed data governance, with mutual trust and adequate distribution of the value created by sharing data.

The following technology areas for data-driven industrial environments will be prioritised:

- Development of technologies and definition of specifications and standards for data, products, and/or business processes, that can be agreed and commonly used by many industrial actors, and that have the potential for the emergence of future digital value chains, identify promising industrial areas and organisational models that facilitate cooperation and collaborative product and service design among industry players facilitating industry agreements.
- Quick uptake of advanced 5G technologies by European manufacturing sector to support the convergence towards greater exploitation of industrial data and increase resilience and cybersecurity by design. Private 5G networks (5G NPN) are exclusive mobile networks that manufacturers can use for a defined local production site; they can be tailored to the individual needs of the manufacturer and meet future requirements in the area of Industry 4.0. Innovative approaches to simplify the deployment and operation of such private 5G networks throughout their life cycle are needed. Implementers in industrial environments need to take a holistic view, including both the connectivity infrastructure (with 5G as a central component) and the actual production system. An important element for rapid deployment is also the development and evaluation of new business models for private 5G networks. In particular, projects should offer opportunities for new players that have their main focus on non-public (campus) networks (NGN) for connected industries and in particular automation applications. Projects will aim at "Zero-Touch Management", using network automation, AI / ML, Self-organizing Networks (SON), etc. and taking into account the specifics of industrial environments.

Projects are encouraged to develop toolkits of open hardware, software and toolware, and qualify the use of these to provide opportunities to SMEs to further automate and digitalise their manufacturing, through, for example, OPC-UA and Administrative Shell (AAS) as well as further development on top of these Industrial Internet standards and their inherent cyber security demands for Operational Technology environment.

The distributed industrial computing environments will be demonstrated effectively in a minimum of two specific manufacturing applications. The topic will integrate new or existing technologies to make them practically and economically viable in the industrial world, and will encompass modern manufacturing technologies such as digital twins.

This topic implements the co-programmed European Partnership on Made in Europe.

A new way to build, accelerating disruptive change in construction

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-10: Digital permits and compliance checks for buildings and infrastructure (IA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Efficiency and productivity gains in design and construction processes;
- Fewer errors in planning, design and construction processes;
- Automated, faster, more accurate and more efficient permitting and compliance for construction works (e.g. regulatory, health and safety, performance);
- Improved build quality and resource efficiency in construction.

Scope: There is a need to develop, connect and align new technologies and digital tools for construction, including improved and automated methods of designing, building and authorising construction works. The manual processing and delivery of administrative, legal and regulatory information such as planning and construction permits, and related compliance processes, are complicated and lengthy procedures. This leads to delays and ambiguity in the construction process, as well as errors, extra costs, waste and inefficiency.

Information generated or imported into digital models during early design phases can potentially streamline the application and granting of digital administrative permits. This will in turn facilitate informed decision making including compliance checks later in the design and construction process and throughout the life cycle of the built asset.

Proposals should:

- Develop and demonstrate novel ways of digitalising permitting and compliance processes for construction works;
- Demonstrate new tools and solutions for the storing, processing, analysis and retrieval of administrative and regulatory information related to construction works. The new solutions should make use of neutral data formats, addressing rule interpretation and machine-readable information, and supporting analysis and exploitation of relevant digitalised acts, regulations, requirements and standards;

- Ensure that the new solutions are interoperable and integrated, where relevant, with other relevant tools, databases and processes. These can include Building Information Models (BIM), Geographic Information Systems (GIS), public registries, Life Cycle Analysis data, digital twins including those of greater scale (e.g. city, regional or national level), 3D cadastre, digital building logbooks, and models of larger scale of the built environment, including those that are handled by public authorities. Proposals should ensure that spatial information, where relevant, aligns with the aims of the INSPIRE Directive³;
- Ensure that the new solutions developed can handle a wide variety of relevant data, for example spatial and location data relating to the buildings or infrastructure and their context; urban height limits and setbacks; visual corridors or protected views; environmental information such as flood risk models and protected trees; cultural heritage rules and protections; utilities and services including energy, water and telecoms infrastructure;
- Develop solutions that harness the potential of digitalisation to accelerate processes and improve productivity, open up new methods of working and business models. For example, proposals should make use of disruptive technologies such as Artificial Intelligence, algorithm based checks, Human Aided Design and Compliance;
- Address potential barriers to the use of digital building permits and compliance checks including knowledge gaps, technology deployment, and the regulatory and policy context;
- Take into account the wide range of actors involved in applying for, receiving and using permits and the related compliance (e.g. design, engineering and other construction professionals, researchers, industry especially SMEs, and public authorities), taking into consideration questions of accessibility and user acceptance;
- Take into account the international contexts and developments in construction-related data including BIM and GIS but also the capacities and opportunities presented in different parts of Europe. Proposals should therefore build on previous research, such as the outputs of the DigiPLACE project⁴;
- Address the potential for upskilling and re-skilling of the construction value chain as a result of the innovation;
- Contribute to an EU-wide framework for the digitalisation and automation of machine readable permits and compliance checks for construction works, including by collaborating with similar projects including those funded under this call;
- Develop technical guidelines and semantic models applicable to different EU countries.

³ See <https://inspire.ec.europa.eu/about-inspire/563>

⁴ See <https://cordis.europa.eu/project/id/856943>

Proposals may address any or all types of buildings and infrastructure as appropriate.

HORIZON-CL4-2021-TWIN-TRANSITION-01-11: Automated tools for the valorisation of construction waste (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Reduce significantly the construction and demolition waste (CDW) generation (at least 80% weight) by re-use and transformation of waste into secondary products in full cooperation between construction and waste management companies;
- Provide new value chain and sustainable business models for construction waste reduction mobilising cross sectorial actors;
- Implement appropriate tracing of material and /or component along the new value chain.
- Increase by 50% the reusability potential of construction products post demolition and reduce the down cycling of construction waste by facilitating modular dismantling of complex construction products;
- Plan a list of actions for overcoming relevant barriers (e.g. end of waste criteria, lack of trust in secondary products, awareness of circular potential);
- Develop holistic and replicable solutions for more circular and climate neutral construction materials and activities involving upstream and down-stream actors.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Based on volume, construction and demolition waste (CDW) is the largest waste stream in the EU. Considering that most of the waste share is glass, concrete and steel, the embodied energy and CO₂ emission in the CDW is significant (8.5 MT eq. CO₂ for construction in Sweden in 2015). By reusing and recycling CDW in new constructions, the

sector would come closer to the targets of becoming fully circular and climate neutral. Precise quantitative and qualitative waste estimation is crucial for waste management. This could be achieved by utilising digital technologies for instance Building Information Modelling (BIM), material and component tracing, dedicated apps for construction/de-construction and optimize site management. Such tools could provide data about material type and composition (e.g. whether there are hazardous materials that require special care) and quantities, and thus an estimation of the logistics needs, cost, etc. and make waste separation easier and faster, e.g. by combining with automated equipment and robots.

Proposals should:

- Develop, test and promote the necessary digital tools for material and/or component tracing and CDW management in different types of constructions sites;
- Develop automated solutions for de-construction and waste separation process;
- Implement cross-sectorial holistic solutions involving glass, concrete, steel, ceramics, non-ferrous, etc. from the construction product and material side but also waste management, transportation and construction equipment and machinery side;
- Produce all required training material for the proper use of the developed technologies. The content should be sufficiently inclusive and encompass the diversity of different users;
- Demonstrate all developed solutions in at least four implementation sites across different Member States;
- Assess the value of the solutions in terms of the additional monetary value/reduction of CO₂ emissions produced;
- Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes. The projects should provide contributions to relevant standards.

In order to achieve the expected outcomes, international cooperation is advised, in particular with Asian countries.

HORIZON-CL4-2021-TWIN-TRANSITION-01-12: New breakthrough technologies for technological sovereignty in construction (IA)

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

<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Integrate new breakthrough technologies such as additive manufacturing and robots/robotic arms into construction activities;
- Demonstrate the impact of the use of these new breakthrough technologies on the efficiency of resources (raw materials, water, etc.) and the reduction of waste and embodied CO₂ emissions;
- Demonstrate the safety of these breakthrough technologies on a construction environment in cooperation with workers;
- Improve the wellbeing of the construction sector workforce.

Scope: There is a global trend for higher digitalisation in the construction sector. To maintain its technological sovereignty and global competitiveness in construction, the European Union should develop its own digitalisation technologies for the sector. Currently, the construction sector is among the least automatised and digitised sector and the most labour accident-prone sector in the European Union. The use of technologies such as additive manufacturing (3D-printing), autonomous vehicles, robots/robotic arms, etc. at a construction site would ensure the technological sovereignty of the European construction sector by increasing the degree of digitalisation of the sector. At the same time, many Member States are facing a shortage of skilled labour force. A higher degree of digitalisation would also make the construction sector attractive for younger generations and construction sites a safer working environment.

The projects should:

- Develop, test and promote the necessary technologies, devices and systems for an highly automatised construction site with the use of technologies such as (but not exclusively) additive manufacturing, autonomous vehicles and robots/robotic arms;
- Demonstrate all developed solutions in at least four construction sites across different Member States;
- Develop solutions for monitoring the wellbeing of the workforce and prevention of accidents taking into account gender and intersectional perspective;

- All solutions developed should be evaluated by the users (site management, workforce, etc.) through surveys or other means;
- Include a business case and a dissemination and exploitation strategy as requested by the Work Programme;
- Consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes;
- Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes;
- Contribute to the development of new relevant standards or update of existing ones.

In order to achieve the expected outcomes, international cooperation is advised, in particular with Japan and/or South Korea.

Hubs for circularity, a stepping stone towards climate neutrality and circularity in industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-14: Deploying industrial-urban symbiosis demonstrators for the utilisation of energy, water, industrial waste and by-products at regional scale (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Deploy the concept of Industrial-Urban Symbiosis (I-US) on a real scale demonstrator, making the flows of energy, waste and water circular, achieving near-zero GHG emissions and near-zero water discharge;
- Reduce by 50 % (in weight or volume) industrial waste generation and reduce significantly the associated GHG emissions, by re-using and transforming waste, by-products and side-streams into new resources or raw materials;
- Provide sustainable new value chains and business models;
- Plan a list of actions (e.g. awareness of circularity potential) to overcome non-technological barriers for exploitation (i.e. waste regulations, standardisation, confidentiality and compliance, ownership, fair sharing of benefits, acceptance of the concept);
- Develop best practices knowledge-sharing on technological and non-technological aspects (i.e. job profile optimisation) in close collaboration with the European Community of Practice (ECoP) CSA and other relevant bodies, dissemination the major innovation outcomes to support the implementation of I-US;
- Plan actions to exchange knowledge and human capital with the local educational establishments and develop flexible learning resources;
- Explore and illustrate replication potential in other regions (by setting up a network amongst waste associations to optimise flow of secondary raw materials for example);
- Implement a social innovation spin-off action involving local authorities, civil society, businesses, especially SMEs, and educational establishments.

Relevant indicators and metrics, with baseline values, should be stated clearly in the proposal.

Scope: In March 2020, the European Commission launched the Circular Economy Action Plan for a cleaner and more competitive Europe. In order to accelerate the transition to a circular economy, exemplary pilot solutions integrating industrial urban symbiosis need to be exploited. The solutions could cover the reduction of waste, virgin raw materials and energy and water consumption, mainly by transforming underused waste materials (both industrial waste and by-products and end of life urban waste) into feedstock for the process industries (urban mining). To support a wide implementation of industrial urban symbiosis for waste utilization, the regional dimension is important since local energy and utility networks, adjacent industrial infrastructures and available by-products and would have to be considered in a holistic approach. In the same way, logistics should be optimised wherever possible and should be an advantage from the sustainable and competitiveness perspective.

Technology based innovations should prove the potential for novel symbiotic value chains in demonstrators involving multiple industrial sectors (combining non-exhaustively energy, process and manufacturing industries) in pilot industrial settings. Projects are expected to address:

- A broad cross-sectorial symbiosis and circularity implementation from a regional perspective to potentially achieve climate neutrality by 2050 including cooperation with other suitable regions in terms of availability of resources, technologies, available infrastructures and knowledge transfer;
- Cross-cutting solutions (processes and equipment) for the processing of side/waste streams specifically for the use as feedstock for plants and companies across sectors and/or across value chains, while increasing the resource efficiency/circularity in industrial value chains and product-life cycles;
- Process (re-)design and adaptation to integrate new processes (energy and material flow coupling, infrastructure and logistics) and create new synergies between sectors;
- Integration of novel sensing technology, IoT and digital tools to support design, flow optimization and controls;
- Concepts, tools and business models for the flexible and robust management of exchange streams in dynamic production environments to maximise the impact on sustainability while respecting the technical limitations, economic interests of the producers and the interests of citizens;
- IT infrastructures and tools that provide a secure basis for the integrated management and the preservation of confidentiality of sensitive data;
- Assessment methodologies and KPIs to measure the performance of symbiosis, including environmental, economic and social impacts (including SRL). Life cycle assessment and life cycle cost analysis should take into account existing sustainability standards (e.g. ISO 14000) and existing best practices;
- Development of common reporting methodologies for the assessment of industrial symbiosis activities and exchanges;
- Tools to support companies in redefining their products process and systems from the point of view of design, production, logistic and business models, preferably based on the outcomes of previous projects (see for example SPIRE project portfolio on Industrial Symbiosis);
- Study social aspects of the community and its improvement through the I-US where demonstration pilot is located (social innovation, underdevelopment, job quality gender and inclusiveness perspective);
- Create societal awareness through a participative approach locally and more broadly, highlighting and communicating political and regulatory obstacle between regions/countries.

Clustering and cooperation with other selected projects under this cross-cutting call and other relevant projects as well as building on existing projects (Sharebox, Scaler, CIRCLEAN

network for example) is strongly encouraged, see also Industrial Symbiosis Report from March 2020⁵.

In order to achieve the expected outcomes, international cooperation is advised, in particular with partners from Korea and Japan.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-TWIN-TRANSITION-01-15: Circularity flows for solid waste in urban environment (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Deploy the concept of Industrial-Urban Symbiosis (I-US) on a real scale demonstrator, making the flow of solid waste circular in process, manufacturing and/or construction industries;
- Reduce 80 % (in weight or volume) solid waste generated in comparison to current state-of-the art, by re-using and transforming waste, by-products and side-streams into new/secondary resources of raw materials;
- Plan actions (e.g. awareness of circularity potential) to overcome non-technological barriers for exploitation (i.e. waste regulations, standardisation, confidentiality and compliance, ownership, fair sharing of benefits, acceptance of the concept);
- Develop knowledge sharing: know-how, challenges and recommendations on technological and non-technological aspects (e.g. job profile optimisation) with the European Community of Practice (ECOP) and other relevant bodies, disseminating the major innovation outcomes to support the implementation of I-US;

⁵ Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis
<https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1>

- Plan actions to exchange knowledge and human capital with the local educational establishments;
- Explore and illustrate replication potential in other regions (e.g. by setting up a network amongst waste associations to optimise flow of secondary raw materials);
- Implement a social innovation spin-off action involving local authorities, civil society, businesses, specially SMEs, and educational establishments.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Hubs for circularity for solid waste in urban environment tackles a fundamental issue of end of life materials representing a huge amount and broad range of solid wastes. Solid wastes is one of the biggest waste streams in Europe, accounting for more than [30% of all waste](#) generated in the EU (Dec.2019 data), re-using and re-cycling most of that could cut significantly the emissions caused by the mining and manufacturing needed to produce those materials in the first place and as such represents an important decarbonisation potential. Solid waste are intended here as process industry, manufacturing industry, construction industry waste and solid urban waste (consumer waste, End-of-Life waste). There is a need of innovative solution engaging waste management actors in novel value chains to valorise a significant part of those wastes, bringing full attention to upcycling back to secondary materials instead of down cycling of low re-use.

Projects are expected to address:

- Management and processing of waste streams through e.g. collection, disassembly, sorting, purification, concentration, recycling (especially chemical recycling), exchanging or preparation, for the valorisation of waste to be used as feedstock for other plants and companies across sectors and/or across value chains;
- Process (re-)design and adaptation to integrate new value chain including energy, water and material flow, infrastructure and logistics;
- Question of the availabilityAvailability and distribution of “waste” resources and logistic will need particular attention: how to be sure to get the specified material of the right quality and quantity for the process we need to feed;
- Integration of novel sensing technology, IoT and digital tools for the classification and sorting of solid waste streams to enable their efficient utilisation with as little downgrading as possible;
- New approach to end-of life materials removing the usual barriers of exploitation, enabling novel symbiotic interactions; unification of administration procedures, data sharing and preservation of data confidentiality;

- **Assessment** Define assessment methodologies and evaluate KPIs to measure the performance of symbiosis, including environmental, economic and social impacts; (including SRL);
- Life cycle assessment and life cycle cost analysis should take into account existing sustainability standards (e.g. ISO 14000) and existing best practices;
- Assessment of the economic, circularity and climate benefits;
- Study social aspects of the community and its improvement through I-US where demonstration is located, whilst also considering a gender and inclusiveness perspective;
- Create societal awareness through a participative approach locally and more broadly, highlighting and communicating political and regulatory obstacle between regions/countries.

Clustering and cooperation with other selected projects under this cross-cutting call and other relevant projects as well as building on existing projects is strongly encouraged, see also Industrial Symbiosis Report from March 2020⁶.

Proposals should further address the following aspects: Take account of the EU taxonomy on Sustainable Finance. The design and deployment of the technologies proposed should enable the relevant activities of technology application to meet and where possible exceed their respective climate change mitigation targets (technical screening criteria for “significant contribution” and the “do no significant harm”). Demonstrate the approach to comply or exceed the relevant criteria thresholds of the EU taxonomy on Sustainable Finance. The envisaged level of ambition for aligning or exceeding of the criteria thresholds would be an added value considered in the evaluation.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-TWIN-TRANSITION-01-16: Hub for Circularity Community of Practice (ECoP) platform (CSA)

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

⁶ Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis
<https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1>

<i>Funding rate</i>	100%
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- Establish a European Community of Practice (ECoP) as an effective and sustainable forum/platform connecting hubs for circularity (H4C) and all actors willing to invest in industrial urban-symbiosis (I-US), towards building new circular value chains;
- Appropriate up-to-date support, by the ECoP, to the H4C by collecting knowledge and tools and making them accessible training material dedicated to circular practitioners that can drive the H4Cs roll out across Europe;
- Analyse collaboration models, non-technological barriers, tools, technologies and existing solutions for I-US and circularity, especially those from previously funded projects;
- Provide a state-of-the-play analysis of regions/areas best suited for the first implementation of advanced H4C in Europe, coupled with a detailed study of the strength and weaknesses of the regions/areas selected, including a Symbiosis maturity level (SRL)⁷ and a number of specific scenarios for the technology and process implementation;
- Establish a roadmap on how to achieve an effective implementation of a certain number of first-of-a-kind pilot advanced H4C by 2025, supported by a solid blended funding strategy, targeting a significant level of circularity by 2030;
- Spread the H4C concept to all regions of Europe, support the H4C cooperation network and promote the transfer of the circular models across sectors and borders;
- Stimulate circularity public and private investments;
- Provide a solid plan for self-financing the ECoP in the long term from once funding has ended;
- Foster business-to-territory relationships in the area in which the H4C, or neighbouring H4C, are placed (i.e. with authorities, SMEs, associations, educational organisations, civil society, etc.).

Scope: In March 2020, the European Commission adopted a legislative proposal for a European climate law setting the objective for the EU to become climate-neutral by 2050, reinforced by the 55% GHG reduction target set in Climate Target Plan in September 2020. Circularity is an essential part of the industry transformation towards climate-neutrality and long-term competitiveness. H4C are defined as first-of-a-kind, lighthouse demonstrator plants of commercial size implementing industrial symbiosis or urban industrial symbiosis with the aim of achieving a step change in circular utilization of resources and GHG emission

⁷ Industrial symbiosis report published in March 2020

reductions, within a given representative geographical area. H4Cs have strong technological focus and industrial dimension, but their implementation leverages elements well beyond R&I. Specific implementation (including funding) strategies will have to be designed, ensuring the participation of all stakeholders (Industry, SMEs, local authorities, educational institutions and civil society). The common target is to collectively achieve and demonstrate at scale a leap towards circularity and carbon neutrality in the use of resources (feedstock, energy and water) in a profitable way.

The H4C European Community of Practice is a tool for connecting the Hubs and the community of interest into a network for exchanging tools and knowledge across regions. The project will embrace possibly all existing H4Cs and circular systemic activities and strongly link with the activities of relevant European Partnerships, such as Processes4Planet.

The ECoP should:

- Gather and synthesise state-of-the-art knowledge on circularity and industrial symbiosis and work out their benefits for climate neutrality and competitiveness;
- Characterise, classify and evaluate systematically symbiosis and circularity-related solutions with a constant update symbiosis and circularity-related solutions;
- Draw up a list of specifications/criteria for best suited areas/regions taking into account lifting up or expanding existing hubs;
- Analyse in detail suitable regions/areas in the EU for H4Cs implementation. The regions/areas to consider should involve resource streams from consumer waste, urban wastewater and waste streams, preferably I-US scenarios and infrastructures that are already in place, as well as, potential public or private financial support (grants and investments);
- Analyse proven involvement of regions and local communities;
- Preferably, the SRL level defining maturity of symbiosis processes should be significant;
- Shortlist regions/areas, for developing the first demonstrator of H4C by 2025. These hubs should become lighthouse examples of win-win cooperation between industry, SMEs, public authorities, educational institutions and civil society on circular economy beyond 2025;
- The H4C could be thematic at first (e.g. focus on valorisation of emissions or circular use of plastic waste, etc.) and evolve after a successful first demonstration into a broader concept, attracting other players from other industry sectors at local, regional, national or European level and enabling industrial symbiosis in new areas and processes;
- Provide a pre-implementation analysis of the first listed regions/areas. This should, at least, include technical and non-technical challenges, various proposal for symbiosis process implementation, commitment level of the local authorities and communities,

regional specificities (business/industrial policy and strategies), additional funding and state-aid resources, etc;

- Propose stakeholder events for local and regional authorities creating awareness on industrial opportunities and challenges based on the analysis;
- Connect the regional H4C and ensure a mutually profitable knowledge and experience exchange;
- Provide support and advice to the community members, as well as, tutorials and learning framework about state-of-the-art solutions (for technical and non-technical problems);
- Promote the role of enablers/facilitators as a new type of service to industry, regions and civil society;
- Support the transfer of knowledge, tools and innovation across the H4C, and the programming groups or ad-hoc task forces;
- Engage with stakeholders, such as, universities or other educational institutions to facilitate the training of circular practitioners. These practitioners should have an in-depth understanding of I-US, the state-of-the-art tools and databases and newest business models;
- Track regional needs based on feedback of H4C and other supporting members in order to optimise the support;
- Enable and regularly update evaluation of I-US projects by providing systematic knowledge on gaps and potential impacts, and favour connection with regions/areas of high potential for a first successful implementation of a H4C;
- Identify potential sites for setting up emerging new hubs based on mapping of I-US and circular activities as a continuous update and extension of the pre-implementation analysis.

The EU funded projects under P4Planet and others dealing with circularity will be required to provide complete information and full collaboration to the ECoP platform.

Cooperation with other selected projects under this cross-cutting call and other relevant projects as well as building on existing projects (Sharebox, Scaler, CIRCLEAN network for example) is strongly encouraged, see also Industrial Symbiosis Report from March 2020.⁸.

This topic implements the co-programmed European partnership Processes4Planet.

⁸ Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis
<https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1>

Enabling circularity of resources in the process industries, including waste, water and CO₂/CO

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-17: Plastic waste as a circular carbon feedstock for industry (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Valorise a wide variety of unsorted plastic (and other) waste in large amounts, to avoid landfill;
- Yield material streams of high industrial interest, replacing the ones currently produced from fossil feedstocks (e.g. olefins, hydrogen, syngas, etc.);
- Develop concepts enabling 100% utilisation of RES (e.g. electrified processes), coping with potential fluctuations in the energy supply;
- At least 60% GHG emissions reductions in the overall lifecycle compared to existing processes for plastic recycling (or relevant benchmark).

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Plastic (and other) waste, such as packaging, textiles, etc., could potentially represent a sustainable alternative to imported feedstock (e.g. oil, gas). It contains high amounts of carbon, it is widely available and its valorisation could also provide environmental and societal benefits avoiding the disposal in landfill.

The proposals submitted under this topic are expected to provide concepts for utilisation of unsorted plastic (and other) waste in cracking applications, including e.g. packaging, non-sorted polymers and single use items such as PPEs, for the production of material streams of

wide industrial interest (e.g. hydrocarbons, olefins, syngas, hydrogen, etc.). The technologies proposed should be electrified to work efficiently in a renewable based energy system. They should also be able to cope with potential fluctuations in energy supply.

- The technologies proposed should be able to valorise a wide variety of unsorted waste, plastic could be a major source, other waste sources can be considered (e.g. textiles), providing the supply is secure and the business case is feasible. Special attention is required to the potential variability of the input, and the presence/formation of contaminants and impurities in the process;
- The processes addressed should yield material streams which are of high industrial interest and can be readily integrated in downstream industrial processes for the production of a wide range of products (e.g. plastics, chemicals, hydrogen, fuels, fibres, materials, fertilisers, etc.);
- Industrial specifications should be considered, and proof that these secondary raw material streams can be used in downstream industries should be provided;
- Demonstration of the improved environmental footprint of the proposed products and processes, as well as their positive impact should be provided using relevant methodologies (e.g. LCA, LCSA, etc.). The prevention of upcycling of hazardous substances and their separation and disposal should be considered;
- Elements related to the replicability and scalability of the technology should be provided. Along with the relevance of the proposed approaches to solving waste related issues in existing European contexts;
- Demonstration of the proposed concepts in an industrially relevant environment and at an appropriate scale are expected. The integration of the proposed technology in existing value chains and industrial realities would be an added value.
- Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes.

In order to achieve the expected outcomes, International Cooperation is encouraged, in particular with Japan, Korea, India or ASEAN countries.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-TWIN-TRANSITION-01-18: Carbon Direct Avoidance in steel and other metals: Electricity and hydrogen-based metallurgy (IA)

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

<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>To ensure a balanced portfolio covering steel and other non-ferrous metal sectors, projects will receive funding not only in order of ranking but also considering the highest ranked within the specific aspects of the topic (i.e. steel sector, other non-ferrous metals), provided that the applications receive the minimum score in all thresholds according to a balanced distribution of the budget.</p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by improving energy efficiency in raw materials value chains.

Projects are expected to contribute to the following outcomes:

- Demonstration of technologies in the steel and other metals sectors leading to a reduction of CO₂ emissions by 2050 by at least 80 to 95% compared to 1990 levels;
- Improve energy and resource efficiency and increase utilisation of renewable energy sources⁹ in metallurgical processes to substitute fossil fuels;
- Enabling steel and non-ferrous metals production through carbon direct avoidance (CDA) technologies at a demonstration scale.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: This topic covers carbon direct avoidance technologies leading to significant CO₂ emission reduction in both the steel and other non-ferrous metals sectors. Specific research and innovation areas for these sectors are described below with the aim to address projects contributing in the different areas.

Projects in the steel sector

⁹ Biomass utilisation in line with the objectives of the EU Biodiversity Strategy.

The Commission's Strategic Vision "A Clean Planet for all" indicates that deep CO₂ emissions reductions in the steel sector are possible through a combination of technological pathways, including steel recycling, carbon capture utilisation and storage, process integration, and electricity/hydrogen-based metallurgy. While energy intensity has reduced significantly over the past decades, the steel industry remains a large source of emissions due to preferred use of coal and energy needed to reduce iron oxides. With alternative pathways used with green electricity and green gases, the emissions can be further reduced so that these pathways could achieve CO₂ reductions of up to 95% by 2050 compared to 1990 levels.

There is no one solution to achieve low-CO₂ steelmaking, as there is expected to be a variety of production technologies in the future. The projects proposed are expected to address the following research and innovation areas:

- Replacement of fossil carbon energy by renewable (hydro/wind/solar) electricity in iron and steelmaking;
- Development of pilots and demonstrators in the field of direct reduction of iron with hydrogen. Direct reduction of iron ore with high amounts of hydrogen is expected to be key for CO₂ neutral steelmaking;
- Improvement of plasma melting processes with improved electrode technologies using a plasma torch or plasma smelting reduction leading to CO₂ reduction compared to fossil-based fuels;
- Development and testing of direct electricity based iron oxides reduction processes including the electrolytic reduction at high or low temperature;
- Innovation activities concentrate on the process and the product properties as well as on the impact of the product properties on the downstream processes (e.g. Electric Arc Furnace). The process technology may have to be adapted to the new boundary conditions;

This topic area implements the co-programmed European Partnership on Clean Steel for projects in the steel sector.

Projects in non-ferrous metals sectors.

The EU non-ferrous metals sector has the potential for an 81% overall reduction in greenhouse gas emissions (vs. 1990 levels), once indirect emissions are eradicated in a decarbonised EU power sector and the climate-neutral transition pathway could encompass breakthrough technologies as follows:

- New digitisation and automated process management and energy efficiency in furnaces;
- Innovation in electrolysis process such as inert anode technology for further efficiency gains of up to 20% and direct emissions reduction while reducing energy use;

- Further electrification of pyrometallurgical processes and/or shift to hydrometallurgical processes in smelting processes;
- Shifts to bio-based energy and bio-feed¹⁰ in non-ferrous metals industry, specifically for recovery of metals from smelting slag or leaching residues;
- Non-carbon reducing agents/hydrogen for pyro smelting processes (e.g. copper) and for recovery of metals from smelting slag or leaching residues;
- CCUS in silicon and alloys production;
- New hydrometallurgical and pyrometallurgical technologies to recover metals (incl. precious and rare) from waste and secondary streams (residues, slags, scraps).

HORIZON-CL4-2021-TWIN-TRANSITION-01-19: Improvement of the yield of the iron and steel making (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Validate at industrial test scale technologies for impurity removal from scrap or the recovery of metal fractions contained in steel making process residues (that are today mainly landfilled) reaching high recycling rate of residues originated at the demo site up to 40% achieving a metal recovery efficiency up to 90% and a mineral recovery efficiency up to 80%;
- Progressively increasing the uptake of low-quality scrap grades into high quality steel grades;
- Progressively replacing the use of pre-consumer scrap grades with high quality clean scrap grades;
- Progressively replacing the use of solid pig iron produced by traditional BF process with post-consumer grades;

¹⁰ Bio-based energy and bio-feed in line with the objectives of the EU Biodiversity Strategy.

- Reducing the environmental impact by minimizing CO₂ emission up to 20% both, directly (and locally) by internal recycling of the metal fraction derived from residues, or indirectly by increasing the use of scrap as raw material in steelmaking production processes including:
 - o the reduction of pig iron use the in the steelmaking process;
 - o the use of alternative reducing agents as coal substitution, such as biomass, polymers, hydrogen;
 - o the reduction of CO₂ emission derived by extraction and transportation of natural resources as well as transportation and landfill of industrial waste;
 - o the generation of CO₂ neutral energy vector from chemical and sensible heat from pyro-metallurgical residue treatment processes allowing at least 5% reduction of specific energy consumption for a dedicated process.
- Develop novel technologies for onsite characterization (chemical and physical) of ferrous materials to help standardization of charge managing practice;
- Confirming the replicability of the demonstration plant in most of EU steel shops.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: R&I areas that needs to be tackled should address some of these aspects:

- Selection and integration of best available and applicable technologies to reduce impurities in post-consumer scrap before melting together with scrap yard management supported by digital smart tools for scrap classification and charge optimization; these are key elements to increase the use of scrap achieving the same quality of the finished product in both, the EAF, and BF/BOF route and at the same time reducing CO₂ emissions due to lower energy need with respect to iron-ore;
- Development, deployment, and use of smart sensor and dedicated Big Data analytics to develop and further optimize decision-supported systems for helping steel plant operators to increase the process yield and to improve the final steel product quality. The projects should ensure involvement of operators and process experts in development and implementation of Big Data, ensuring the uptake of human experiences and a user-friendly processing of results;
- Realisation of demonstration plants at relevant industrial scale focusing on material upgrading technologies (cleaning, size control) as well as inline characterization of ferrous materials via novel technologies for onsite characterization (chemical composition and physical properties);
- Development and implementation of highly efficient technologies for recovering metals and mineral fraction from steelmaking residues, including those coming from H₂-based metallurgy ones, with high metallic or oxidic fractions; two possible ways are

envisioned, whereas the first one is based on cooling and mechanical steps, such as wet or dry granulation followed by phase separation; the second one relies on a direct recycling of residues in existing production processes or in dedicated pyrometallurgic melting and reduction units;

- Full by-product testing and evaluation to have them covered by a standard like a CEN Workshop Agreement (CWA) or by a national technical agreement;
- Enabling the use of obtained by-products in higher value applications (i.e. filtering, coating, additive manufacturing, material for CO₂ sequestration, heat accumulator);
- Integration of energy recovery solutions in metal recovery processes targeting at a better Return of Investment.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2021-TWIN-TRANSITION-01-20: Reducing environmental footprint, improving circularity in extractive and processing value chains (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce dependence of extractive activities on carbon-related energy sources and process emissions, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is</i></p>

	<i>possible and allowed, and if yes, how this must be legally formulated.]</i>
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Reduce environmental impact of extractive and processing value chains;
- Develop demonstrators and pilot plants with a lower environmental impact;
- Reduce environmental footprint and circularity of extractive and processing value chains;
- Developed methods, technologies and processes for mining and processing aiming at significantly decreased emissions (CO₂ and other emissions);
- Significantly increase resource and energy efficiency, and increased circularity of raw materials together with increased valorisation of extractive waste;
- Contribute to meeting the goals of climate neutrality, circularity, zero pollution and system protection, sustainable use and restorations as spelled out in the European Green Deal.

Actions are expected to contribute to the implementation of the following actions of the EU action plan on Critical raw materials (reference, to be adopted in autumn 2020):

- Use Horizon Europe funding for research into mining processes with minimal impact on the environment and life-cycle assessment;
- Support waste and extractive waste valorisation and energy efficiency through cross-sectoral cooperation and industrial symbiosis, involving the mining industry.

Scope: Actions should develop sustainable solutions to reduce dependence of extractive activities on carbon-related energy sources and process emissions. They should also address reducing materials use, water and waste valorisation at all stages of the extractive and processing cycle.

Actions should facilitate the market uptake of solutions developed through industrially- and user-driven multidisciplinary consortia covering the relevant value chain and should consider standardisation aspects when relevant.

Actions should justify the relevance of selected pilot demonstrations in different locations within the EU (and also outside if there is a clear added value for the EU economy, industry and society).

The action should facilitate the market uptake of solutions developed through industrially- and user-driven multidisciplinary consortia covering the relevant value chain and should consider standardisation aspects when relevant.

The action should justify the relevance of selected pilot demonstrations in different locations within the EU (and also outside if there is a clear added value for the EU economy, industry and society). The action should include an outline of the initial exploitation and business plans (with indicated CAPEX, OPEX, IRR and NPV¹¹) with clarified management of intellectual property rights, and commitment to the first exploitation.

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

The action should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

Integration of Renewables and Electrification in process industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-21: Design and optimisation of energy flexible industrial processes (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

¹¹ Capital expenditures (CAPEX), operational expenditure (OPEX), internal rate of return (IRR), and net present value (NPV)

<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- Significant increase of the process flexibility and demand response towards the integration of variable energy sources, i.e., renewable energy sources;
- Overall increased energy efficiency of the industrial process within the energy system;
- New digital tools accounting for the energy availability and the additional flexibility of the process for a more efficient energy management system;
- Cost reduction of the overall process through valorisation of excess streams into the energy system.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal

Scope: Flexibility solutions are key to achieve the EU renewable energy target of at least 32% for 2030. In the coming years, EU industries will need to adapt to the increased fluctuations in energy supply caused by the higher penetration of variable energy sources. Besides, an integrated energy system, linking different energy carriers, infrastructures and consumption sectors in the EU, will be set to deliver climate neutrality by 2050 in a cost effective way. The increased value of flexibility will offer competitive opportunities for process industries (additional revenue streams) and enable a leaner energy system.

Process flexibility and efficient energy storage are essential to account for the variable renewable energy production. When less energy is available, process industries can consume less energy or take it from storage; whereas, when there is surplus of energy, the excess energy can be consumed or stored. A fast response rate, i.e., a swift increase or decrease of the process energy consumption, is key in the shift to dynamic operating processes. To leverage the existing flexibility in the process industries, digital process control systems that optimise the process while accounting for the value of flexibility need to be implemented. The better integration of the EU energy system will require greater flexibility. Moreover, the direct integration of renewable energy generation and use for higher overall efficiencies will need further flexibility solutions in process industries.

To respond to the additional flexibility demand, current processes designed to run continuously at maximum capacity can be (partially) redesigned or modified. Onsite storage in the form of electricity, heat or other energy vectors can further increase an installation's flexibility.

Proposals should address the following aspects:

- Identification of potential flexibility in an existing process, which allows an efficient and competitive operation;

- Redesign and modification of the process to enable more flexibility in operation (e.g. process that can run faster or slower depending on the needs of the grid), including the removal of process steps that limit the flexibility;
- Redesign and modification of the process to increase its flexibility response rate (e.g., faster ramp up or ramp down) towards an increased energy efficiency;
- Development or redesign of digital process control systems, supported by integrated analytical tools, to account for the flexibility of the process, and in connection to energy grid integration platforms;
- Optimisation of the new process design at pilot scale.

Onsite energy storage (electricity, heat, or other energy vectors) can be also part of the proposed flexible solution.

Proposals submitted under this topic should include a safety assessment and a life cycle assessment for the implementation of the developed technologies.

Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes.

Proposals should further address the following aspects:

- Take account of the EU taxonomy on Sustainable Finance. The design and deployment of the technologies proposed should enable the relevant activities of technology application to meet and where possible exceed their respective climate change mitigation targets (technical screening criteria for “significant contribution” and the “do no significant harm”).
- Demonstrate the approach to comply or exceed the relevant criteria thresholds of the EU taxonomy on Sustainable Finance. The envisaged level of ambition for aligning or exceeding of the criteria thresholds would be an added value considered in the evaluation.

In order to achieve the expected outcomes, International Cooperation is advised, in particular with US and Canada.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-TWIN-TRANSITION-01-22: Adjustment of Steel process production to prepare for the transition towards climate neutrality (IA)

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

<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Adaptation of the energy and materials flow in the existing steel installations to allow for a technically and economically feasible transition to reduce the use of fossil carbon as reducing agent;
- Reduction of carbon footprint by incrementally adapting to alternative feedstock gases and biomass as reducing agents;
- Showcase new technologies to reduce steelworks energy consumption by implementing improvements in the materials and energy flows whilst reducing fossil carbon related emissions;
- Develop technological pathways to increase the reutilization of internal process metallurgical gases by deploying advanced gas treatment solutions.

Scope: The proposals submitted under this topic are expected to provide concepts addressing the modifications of the existing installations of both primary and secondary steel production (BF/BOF, EAF, DRI) concerning the internal and external flows of energy and materials in order to re-use metallurgical gases (internal re-cycling) and to upgrade them with new sources (H₂), e.g. by replacement of fossil carbon as reducing agent with hydrogen containing gases and biomass.

This also includes the integrated preparation (reforming, separation, heating, compression) of external carbon-lean reducing gases or internally-recycled CO/CO₂ streams for efficient injection in the BF or use in conventional plants.

The concepts to be addressed under this topic are expected to address one or more of the following areas:

- Injection of hydrogen or hydrogen-rich gases (including natural gas, coke oven gas or BOF gas) or biomass to directly avoid the usage of fossil carbon as reducing agent in BF or as heat source in EAF operation;
- New process technologies for co-injection and new injection ports for BF and DRI plants and for EAF technology;
- Advanced gas treatment solutions (purification, reforming, preheating) for steel plants process gases for the purpose of internal re-use;

- Integration of gas injection with CO₂ capture and storage technologies for the transition to CO₂ neutral steelmaking;
- Adaption of the energy and materials flow in the energy system of the steel production process with adjustments of gas distribution/combustion to new gas properties and amounts including new developments regarding the related process technology and control technology.

This topic implements the co-programmed European Partnership on Clean Steel.

Call - TWIN GREEN AND DIGITAL TRANSITION 2022

HORIZON-CL4-2022-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)¹²

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹³	Number of projects expected to be funded
HORIZON-CL4-2022-TWIN-TRANSITION-01-01	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-02	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-03	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-04	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-05	RIA	Around N/A		

¹² 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 2021 and 2022.

¹³ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2022-TWIN-TRANSITION-01-06	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-07	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-08	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-09	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-11	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-12	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-13	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-14	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-15	RIA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-16	IA	Around N/A		
HORIZON-CL4-2022-TWIN-TRANSITION-01-17	IA	Around N/A		
Overall indicative budget				

General conditions relating to this call

<i>Documents</i>	The documents are described in General Annex E.
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General Annex B.
<i>Award criteria</i>	The criteria are described in General Annex D.

<i>Legal and financial set-up of the Grant Agreements</i>	The rules are described in General Annex G.
<i>Financial and operational capacity and exclusion</i>	The criteria are described in General Annex C.
<i>Procedure</i>	The procedure is described in General Annex F.

Green, flexible and advanced manufacturing

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-01: Rapid reconfigurable production process chains (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Achieve a significant reduction in reconfiguration time, which includes all steps between stopping a production, reconfiguration of the individual production steps, requalification, adjustment of the intra-logistics processes, and ramping up to a full production speed;
- Develop validated standardised interfaces and protocols to enable digitalised and thus flexible manufacturing processes;
- Develop protocols for best practices in rapid reconfiguration applicable not only for the products and sectors present in the project, but also transferable to other sectors and application areas.

Scope: In times of disrupted supply chains or rapidly changing customer demands, production lines will need to be built flexible enough to be able to handle these variations. Rapid reconfiguration technologies, will enable industries with many production process steps to maintain a resilience against sudden changes in ordering and/or supplies.

The projects should address reconfiguration of production systems in which the lines are running at medium or high volume manufacturing rates (MVM and HVM respectively), and include a variety of production steps, such as cleaning, forming, thermal treatments, cutting, joining, surface treatments, painting, printing, assembly, etc. It should also consider complex logistics and non-manufacturing operations enabling the production runs.

The reconfiguration should be ambitious to the extent that the change addresses a new customer base or new societal needs, or drastically changes the original production processes and/or supply chain.

Projects should also include protocols for best practices of the reconfiguration that can be applicable also outside the sectors active in the project, which would include taking into account any sector specific qualification requirements (such as clean room levels or certifications for sectors such as medical and food). These protocols as well as the projects should have a human-centred perspective, including skills requirements and training adapted to different education levels and needs.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

In order to achieve the expected outcomes, International Cooperation is advised, in particular with Japan, Korea or Canada.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2022-TWIN-TRANSITION-01-02: Products with complex functional surfaces (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- Develop more efficient manufacturing processes to increase market share increase for products with functional surfaces that contribute to competitiveness and a transition to green and sustainable production flows;
- Significant reduction of the environmental footprint for surface treatments;
- Uptake of treatment technologies in applications for a sustainable society, targeting reductions in energy use and environmental footprint.

Scope: Surface treatments are an integral part of any manufacturing process. Surface treatments include many disciplines, such as painting/coating/printing (spray, powder, dip coating, etc.), plating/implantation (electroplating, vacuum plating, etc.), thermal treatments (annealing, thermo-chemical processes, etc.), laser-based treatments (annealing, texturing, etc.), additive manufacturing, electrochemical treatments (anodizing, electropolishing, etc.), etching (wet etching, plasma/dry etching, also for texturing).

While the integration of these treatment technologies into a manufacturing line has been well reported, the technologies as such need to be adapted for each particular profile. In addition, with progressively more complex and customised requirements on shape, material and functionality, the demands on efficient surface treatments are increasing. In a transition towards a sustainable production, with a substantially lower environmental footprint, the demands are even higher.

The projects under this topic should address the following:

- Develop new surface treatments specifically targeting and enabling end-products with the purpose of reducing the end-products' energy usage and/or environmental footprint. This may include co-design of product geometry and surface properties;
- Use of innovative production technologies for further functional integration and miniaturisation in order to reduce environmental footprints and resource use of products;
- Integrate the new surface treatments in a manufacturing line for profiles with complex shape or multimaterial content, with clear metrics on its efficiency during operation;
- Develop new business models and strategies for the uptake of these new technologies and with clear objectives on how to expand the uptake to other sectors and other applications.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should

develop synergies with existing projects, both European and national, and other initiatives and platform.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2022-TWIN-TRANSITION-01-03: Smart sustainable production of complex products (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Increase of productivity of complex products manufacturing while ensuring high quality, minimising need of reworking, and ensuring sustainability;
- Manufacturing products with complex geometries, structure and materials with a significant reduction of material waste, energy consumption and defects;
- Demonstration of significant quality improvement in several processes for manufacturing complex products, such as joining, cutting/forming, coating, assembly and finishing.

Scope: Products are increasingly complex, e.g. geometries, structures, embedded and structural electronics, micro-features, advanced multi-materials. Moreover, newer constraints are coming from new requirements of sustainability in production processes (resource and energy efficiency).

To maintain technological sovereignty and to enable the viable and sustainable manufacturing of high-tech products, innovative advanced manufacturing processes should be developed. Digital models make development, production, and operation of complex products manageable.

Proposal should cover research activities in the following areas:

- Advancement of smart production technologies such as additive manufacturing and laser-based manufacturing, intelligent and autonomous handling, shaping, coating, and assembly technologies;
- Functional printing to manufacture complex products, such as in-mold electronics and printed electronics (e.g 3D printed, screen printed, etc), and advanced joining processes as a mechanism of enhancing the behaviour and value of mechanical components while reducing non-renewable material usage and allowing flexibility of smart products;
- Use of novel sustainable and smart materials to achieve same or higher technical features in products while reducing environmental impact;
- Parallel product and manufacturing engineering, developing cyber physical systems, e.g. digital twins, to manage complex productions using data spaces across the whole value chain. Multiscale physics-based models and machine learning/AI methodologies to improve prediction capacity/optimisation in manufacturing, remanufacturing and reuse;
- Support the training and knowledge transfer of smart sustainable production processes for complex products.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2022-TWIN-TRANSITION-01-04: Excellence in distributed control and modular manufacturing (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Significant advance in modular technologies for flexible manufacturing operations, which respond to disrupted supply chains, or rapid changes in customer and societal demands;
- Transition of modular technology to sustainable production for varying batch sizes, including single lots, with a clear integration of control and decision-making strategies at different levels;
- Improved understanding among industry users, including SMEs, of how to organise and control reconfigurable manufacturing systems built from modules with defined interfaces, including quality assessments, environmental impact, energy use, end-user involvement and business models.

Scope: Modularity of a production system is crucial for flexibility and allow for varying the production according to needs and circumstances by introducing, changing, and removing different process steps. While the concept of modularity is not new, there is still a vast range of production steps that cannot be considered modular, and the ones that can be considered as such are not necessarily suitable for current demands nor to be considered as a part of sustainable production regimes.

The projects under this topic need to address the following aspects:

- Propose and develop new production modules that cover processes that are not currently readily available on the market and go beyond the current state of the art with a clear alignment of customer needs including taking into consideration biases and gender dimension;
- Create interfaces based on open-source protocols that allow for easily integration of modules in existing lines and with other modules or production elements;
- Create industrial strategies on how to use modularity, including its related service models, to reduce energy consumption and environmental footprint, and demonstrate it in a relevant environment;
- Develop business models that demonstrate the potential of the modular technologies to be transferred from one specific manufacturing sector to several others;
- Support the training and knowledge transfer to relevant parts of the workforce.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2022-TWIN-TRANSITION-01-05: Intelligent work piece handling in a full production line (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Develop highly flexible, resilient, reconfigurable and agile production lines able to handle a variety of different products and materials with high precision;
- Deploy easy to programme advanced handling control systems of complex products in terms of shape, size, material and stiffness;
- Increase productivity by enabling fast and accurate movement of work pieces through the production line, ensuring just-in-time delivery and reducing downtime.

Scope: The global trends towards product customization have increased production complexity. To maintain global leadership and competitiveness of European manufacturing industry, there is need for flexible, resilient, reconfigurable and agile factories. The recent pandemic crisis highlighted even further the need of manufacturing lines that can switch production within a matter of hours.

Products and component handling is an integral part of the manufacturing industry and its optimization increases productivity while minimizing production costs and time. However, the increasing complexity and customization of products coupled to the paradigm shift towards circular economy requires new assembly and disassembly lines able to handle a number of highly varying workpieces which might be available as 3D model or not. Therefore, there is an increasing demand for innovative smart automated handling systems.

Multidisciplinary research activities, including SSH, should cover:

- Development of innovative, efficient and low consumption systems for storage, retrieval, conveying and pick-and-place using a multi-disciplinary approach combining

technologies such as collaborative/autonomous assembly and logistics, smart conveyor belts, advanced robotics, flexible and versatile grippers, IoT, mechanical and optical sensors, image processing, simulation, modelling, data acquisition, data analytics and machine learning;

- Development of advanced and robust handling devices and systems, for efficient manipulation and manufacturing process execution. Integrate advanced control of individual handling devices exploiting advances in AI;
- Achieve a high degree of flexibility and reconfigurability by ensuring interoperability and user-friendliness of both hardware and software;
- The solutions proposed should be able to handle autonomously different types of objects with a significant variety of shape, size and material properties;
- Demonstrate benefits for workers by reducing their involvement in unsafe and unhealthy tasks, improving their working conditions and increasing trust and acceptance towards technology;
- Deploy innovative technologies in at least three manufacturing lines sufficiently diversified, e.g. food & beverage preparation and packaging, metalworking, product assembly, textile processing and production, etc.

Projects should provide strategies for transfer of the developed technologies to other industrial applications and areas, as well as contributions to standardisation. In addition, they should develop synergies with existing projects, both European and national, and other initiatives and platform.

In order to achieve the expected outcomes, International Cooperation is advised, in particular with Japan or Korea.

This topic implements the co-programmed European Partnership on Made in Europe.

Advanced digital technologies for manufacturing

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-06: ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2) (IA)

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

<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>To ensure a balanced portfolio covering all technology areas, grants will be awarded to applications not only in order of ranking but also to at least one project per technology area, provided that the applications attain all thresholds.</p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 8 by the end of the project – see General Annex B.

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

- Making European manufacturing companies, especially SMEs and mid-caps more sustainable and resilient through the best use of digital technologies and upskilling of personnel;
- Making jobs of humans working in the manufacturing sector safer and more attractive for a diverse population of workers;
- Increasing innovation capacity, agility and productivity of the manufacturing sector, in particular for SMEs and mid-caps;
- Increasing the competitiveness of SMEs and mid-caps by reducing the entry barriers to the use of advanced digital technologies, and transferring innovative solutions into the wider manufacturing community.

Scope: ICT Innovation for Manufacturing SMEs (I4MS) aims to support manufacturing SMEs and mid-caps in adopting the latest innovative digital technologies for their business operations. I4MS2 builds on I4MS and addresses more significantly a sustainable and resilient production.

The pandemic and economic crises demonstrated the key role of digital technologies in responding quickly to external changes. Digitalisation improves resilience, agility and competitiveness, and enables cost-efficient production in Europe. It will also support a radical reduction of the environmental footprint of the sector. In this context, experimentation with innovative and secure digital technologies in their production processes, products and business models guided notably by competence centers specialised in the technologies mentioned below will enhance manufacturing companies to successfully manage the twin digital and green transformation of the coming years.

I4MS2 calls for Innovation Action projects that will support European SMEs and mid-caps to innovate and make more sustainable their products, production processes and business models through experimentation and testing. At least 50% of the budget should be allocated to SMEs and mid-caps to participate in the experiments. The proposals may include financial support to third parties to finance SMEs and mid-caps. Proposals should describe their complementarity to existing initiatives, namely the network of European Digital Innovation Hubs, which is supported through the Digital Europe Programme. They should also indicate how they will collaborate with European Digital Innovation Hubs.

Priority should be given to technologies that can:

- Improve the sustainability of processes and products; significantly reduce or reuse waste and lower the energy and carbon footprint;
- Make industrial processes more agile, secure and resilient to future changes;
- Make manufacturing jobs more attractive for humans, whichever the age, gender or social and cultural background, through better human-machine interfaces and more intuitive interaction with digital tools;

The following technology areas should be addressed in proposals:

- Artificial Intelligence applied to manufacturing, with a specific focus of AI applications at the edge;
- Cybersecure Industrial Internet of Things enabling trustworthy sharing of industrial data and value creation, to achieve further flexibility and agility of supply chains;
- Advanced interfaces and collaboration within smart working environments such as collaborative robots.

Proposals may cover one or more of the possible technologies, which should be relevant for the manufacturing sector at large; proposers are requested to identify the centre of gravity of their proposed project.

This topic implements the co-programmed European Partnership on Made in Europe.

HORIZON-CL4-2022-TWIN-TRANSITION-01-07: Digital tools to support the engineering of a Circular Economy (RIA)

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

<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Provide a range of support solutions and innovative digital tools for engineers, technicians and operators on the factory floor, in order to build agile, sustainable and responsive production environment and supply chains, with specific focus on areas such as material saving, repair, re-manufacturing, recycling, and reuse of products and components;
- Reduction of the dependency from imported raw materials or harmful materials for the European manufacturing sector (e.g. by material consumption reduction, material substitution and use of secondary raw materials);
- Define specifications and standards for data, products, and/or business processes, that can be agreed and commonly used by many industrial actors, and facilitate industry agreements on circularity and sustainability through increased data exchange among value chain actors and enable the development of new types of businesses;
- Reduce the skills and knowledge gap for the actors involved.

Scope: The focus is on developing new concepts, methods, and digital tools to support further engineering of the industrial processes for recycling, re-manufacturing, refurbishing, and reuse of manufactured products and components. New solutions will enable remanufacturing and high-quality recycling by digitalisation of product and component information throughout the whole product lifecycle, in line with the 2020 Circular Economy Action Plan.

Another challenge that falls within this scope is the human dimension. The support tools need to work with the user, and training, knowledge transfer, cognitive interfaces, as well as acceptance and uptake will be vital in the solutions proposed.

Proposals should cover all of the following aspects:

- Development of innovative concepts, methods, and tools that track and trace the status of relevant manufactured products and components, such as electronic systems and components as well as machine tools, and increase transparency and accountability for these. Where appropriate, proposals need to be able to link up with manufacturing industrial data spaces platforms for a broader sharing of , so that circular economy data can be shared with a larger set of organisations;

- Inclusion and handling of real-time production data in analysis software and tools, notably for decision making and control, as well as knowledge management;
- Demonstration of the support tools in at least two different realistic production environments with a clear target of improving quality and sustainability with significant economic value. If applicable, legal obstacles to implementation of the proposed solutions should be identified.

Careful consideration for user training and qualification, including a strategy for user acceptance and uptake of the tools in a relevant environment, which will need to include a cross-disciplinary approach and knowledge transfer across sectors.

This topic implements the co-programmed European Partnership on Made in Europe.

A new way to build, accelerating disruptive change in construction

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-08: Safe and secure public infrastructures (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Integrate new technologies for the inspection and maintenance of public infrastructures;
- Demonstrate the impact of the use of these new technologies on the duration of repair and the elimination of possible shutdowns for public safety;
- Demonstrate the safety of these breakthrough technologies for both the inspectors and the users.

Scope: Europe has a large amount of aging infrastructure that needs to be maintained. It is more affordable to inspect and repair in advance (proactive maintenance) than repair once the damage has occurred (reactive maintenance) and even more affordable than to rebuild from the beginning. A proactive maintenance will ensure the safety of both the inspectors and the users while it will cause less disturbance to the users thanks to reduced shutdowns of public infrastructures.

The proposals should:

- Develop automated inspection and maintenance technologies that will enable remote monitoring and repair of tunnels, bridges, high-voltage pylons, telecommunication networks, and other infrastructure that are not easily accessible;
- Produce all required training material for the proper use of the developed technologies;
- Demonstrate all developed solutions in at least four different types of public infrastructures across different Member States;
- Include a business case and a dissemination and exploitation strategy as requested by the Work Programme;
- Contribute to the development of new relevant standards or update of existing ones.

HORIZON-CL4-2022-TWIN-TRANSITION-01-09: Demonstrate the use of Digital Logbook for buildings (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Measurable improvements in resource efficiency and decarbonisation of buildings and their construction/renovation, as a result of using digital building logbooks;
- Improved linkages of existing databases, tools and sources for digital building logbooks;

- Improved usability of digital building logbooks through user eXperience;
- New or improved tools for collection and update of relevant data;
- Demonstrate other benefits of using digital building logbooks e.g. safety and health in buildings and construction; cost effectiveness, efficiency gains in terms of time.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: There is a need to demonstrate and realise the potential benefits of using digital depositories of information that accompany buildings throughout their lifecycle. These digital building logbooks (DBL) can potentially result in greater efficiency, circularity and transparency in the building stock. DBLs should also improve decision making for all actors along the lifecycle of the building.

Proposals should:

- Research and propose innovative approaches that utilise DBL features and functionalities, User eXperience, interoperability, data governance and the connection with other initiatives;
- Demonstrate the benefits of DBL in terms of e.g. productivity, collaboration across the construction ecosystem, resource efficiency, decarbonisation, safety and health;
- Consider both current and future opportunities to collect data from new technologies (e.g. sensors, real-time energy use, drones, 3D scanning) or existing and upcoming platforms (e.g. Sustainable product passports for construction materials) enabling additional data platforms. The DBL could link as well to those new data platforms, which will come with new possibilities and responsibilities in terms of data privacy and security;
- Research and develop common ‘languages’ – interfaces and protocols – to enable interoperability, data consistency (as for example through common European data spaces for the manufacturing sector to ensure enhanced access to privately held data, via industrial data platforms) and information exchange;
- Address the problem of “data matching” and data verification. There is also a high potential for advanced technologies, such as blockchain, to support the alleviation of these issues and the application of such technologies should be explored;
- Consider developing or making use of data quality marking schemes.

The DBL “features” (e.g. digital interface, data syncing, etc.) and “functionalities” (services built around the DBL) should prioritise user-friendliness and a smart interface for end-users. Proposals are expected to demonstrate a “modular and layered” structure for the DBL, developing additional functionalities as extensions to the national schemes, ensuring that it is flexible enough to make the right information available to the right actor at the right time.

Proposals should take into account User eXperience (UX) principles in order to stimulate the update of the building logbook and its use by construction professionals and building owners.

Proposals should ensure that the functionalities offered by DBL and the corresponding benefits are easily understood by construction and building professionals as well as building owners.

Proposals may address the DBL to any or all types of buildings and infrastructures as appropriate.

Enabling circularity of resources in the process industries, including waste, water and CO₂/CO

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-11: Valorisation of CO/CO₂ streams into added-value products of market interest (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Procedure</i>	<p>The procedure is described in General Annex F. The following exceptions apply:</p> <p>To ensure a balanced portfolio covering steel and other energy intensive industry sectors, and in order to fulfil the objective of both partnership initiatives supporting this call, grants will be awarded to applications not only in order of ranking but also considering the highest ranked proposals within the specific aspects of the topic (i.e. steel sector, other energy intensive industries), provided that the applications attain the minimum marks in all thresholds.</p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Utilise CO/CO₂ streams to produce added value products and/or intermediates of wide industrial interest (e.g. polymers, resins, chemicals, food/feed ingredients, minerals, etc.). Excluding fuels and/or energy carriers;
- Enhance the market for CO/CO₂ based products providing economically viable and sustainable alternatives to existing products with strong market interest in one or more applications (e.g. consumer products, feed/food ingredients, automotive, construction, etc.);
- Develop concepts enabling 100% utilisation of RES (e.g. electrified processes, concentrated solar, etc.), coping with potential fluctuations in the energy supply;
- Achieve at least 60% GHG emissions mitigation in the overall lifecycle compared to existing processes for the same products (or relevant benchmark);
- Develop mature technologies for separation/purification of CO/CO₂ containing waste streams to allow the integration in the targeted industry sector/sectors.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: The proposals submitted under this topic are expected to provide concepts for utilisation of CO/CO₂ streams from point sources (e.g. large industrial installation such as steel, cement and chemical plants) converting them into added value products and/or intermediates and chemicals of wide interest (plastics, resins, composites, chemicals). The topic excludes explicitly fuels and renewable energy storage concepts. The technologies proposed should support cross-sectorial concepts and sector integration paradigms. They should also be able to work efficiently in a renewable based energy system, coping with potential fluctuations in the energy supply or be fully self-sustained from an energy standpoint. The concepts proposed are expected to:

- Process significant amounts CO/CO₂ containing waste streams from energy intensive industries, including efficient approaches for the pre-treatment of the gaseous stream (e.g. cleaning, compression, drying, concentration, etc.) if needed;
- Target a range of products and/or intermediates with a wide variety of applications in different sectors (e.g. construction, automotive, food/feed, etc.) to replace existing ones (e.g. fossil based or from virgin raw materials);
- Consider clearly industrial specifications and relevant market requirements;
- Demonstrate that targeted products and/or intermediates can fully replace existing counterparts. The prevention of upcycling of hazardous substances, including their separation and disposal should be considered;
- Demonstrate the improved environmental footprint of the proposed products and processes, as well as other positive impacts using relevant methodologies (e.g. LCA, LCSA, etc.);

- Provide elements related to the replicability and scalability of the technology, along with the potential for applicability in other Energy intensive industry sectors;
- Demonstrate the proposed concepts in an industrially relevant environment and at an appropriate scale. The integration of the proposed technology in existing value chains and the relevance to several European contexts would be an added value;
- Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes;
- **Aspect 1:** Proposals should address primarily energy intensive industry sectors other than the steel sector.
- **Aspect 2:** Proposals should address primarily the steel industry, and the following concepts should also be considered:
 - o In-process integration of CO and CO₂ capture steps in BF-BOF plants;
 - o Development of the carbonisation of steel residues (slags, dust) as a mean to sequester CO₂ by steel specific activities;
 - o Development and energetic integration in steel plants of preparation steps for process gases (cleaning, drying, sulphur removal, CO₂ scrubbing, conversion, compression, heating, reforming, etc). Energetic integration of end-of-pipe capture units in steel plants;
 - o Separation of CO₂, CO, H₂, N₂, BTX, etc from steel process gases for dedicated valorisation and use.

Proposals should further address the following aspects: Take account of the EU taxonomy on Sustainable Finance. The design and deployment of the technologies proposed should enable the relevant activities of technology application to meet and where possible exceed their respective climate change mitigation targets (technical screening criteria for “significant contribution” and the “do no significant harm”). Demonstrate the approach to comply or exceed the relevant criteria thresholds of the EU taxonomy on Sustainable Finance. The envisaged level of ambition for aligning or exceeding of the criteria thresholds would be an added value considered in the evaluation.

This topic implements the co-programmed European partnerships Processes4Planet and Clean Steel.

HORIZON-CL4-2022-TWIN-TRANSITION-01-12: Utilisation of biomass as coal and/or gas substitute in existing steel processes (IA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.

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

- Test, scale-up and optimisation of the integration in steel plants of carbonisation, pyrolysis and gasification processes designed for using biomass as coal and/or gas substitute in existing steel processes (coke plant, sinter plant, BF, BOF, EAF);
- Demonstration of the potential of biomass (in particular from alternative biomass sources in agriculture, paper and food-processing industry, as well as secondary wood, i.e. spent wood from the construction/demolition sector) and spent carbon to increase the overall efficiency of blast furnaces and Electric arc furnaces, leading to a lower coke or injected coals consumption through the execution of validation tests (substitution trials).

Scope: R&I areas that needs to be tackled should address some of these aspects:

- Pre-processing (e.g. drying) or upgrading (e.g. pyrolysis, hydrothermal carbonization, etc.) of biomass and biogas with a special focus on the smart integration in steel plants (energy, logistic aspects, off-gas treatment, etc);
- Production of biogas suitable for the use in steelworks (based on new types of biogenic materials as well as scale-up issues in regard to the quantities required by the iron and steel industry);
- New digital technologies supporting smart integration of biomass as coal/gas substitutes in existing and new manufacturing systems.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2022-TWIN-TRANSITION-01-13: Raw material preparation for clean steel production (IA)

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Projects related to the two main raw-materials in the iron and steelmaking route: the iron-ore and the scrap.

As regards iron ore, the availability of high-grade iron ores is expected to become a more critical factor, as demand will increase. Therefore, technologies for the upgrade and the use of low-quality iron ores are needed. This includes low carbon technologies for sintering/ pelletisation and/or cold bonded iron ore agglomeration.

Projects are expected to contribute to the following outcomes:

- Testing and validation of technologies for the upgrade and the use of low-quality iron ores. This includes low carbon technologies for sintering/ pelletisation and/or cold bonded iron ore agglomeration;
- Identification of best available and applicable technologies for the reduction of impurities in post-consumer scrap;
- Technologies for the valorisation of low-quality scrap streams.

Scope: The concepts to be developed under this topic are expected to address one or more of the following areas:

- Enhanced utilisation of scrap, through improved scrap sorting and removal of scrap pollution, by new detecting technologies. The aim is to remove these impurities before melting, in order to achieve the same quality of the finished product and reducing CO₂ emissions;
- Technologies allowing upgrade processes in low grade iron ores to make them suitable for pelletization or direct use in existing steelworks to address the issue of the availability of high grade iron ores which is expected to become a more critical factor in the coming years as well as broadening the types of ore grades that can be utilized from different sources;

- Application of cold bonded agglomerate: binders, raw materials composition and processing conditions for the use of low quality iron ore grades.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2022-TWIN-TRANSITION-01-14: Technologies for a more efficient utilisation and management of industrial waste waters (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

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

- Provide novel process technologies for a more efficient management of industrial waters, minimising the utilisation of freshwaters and maximising water reuse;
- Provide clear advantages (economic, environmental, social, etc.) on state of the art industrial waste water treatment processes (or relevant benchmark);
- Maximise the recovery of substances (e.g. organic matter, nutrients, etc.) and energy present in the waste water streams, providing integrated solutions for their valorisation (e.g. industry, urban districts, etc.);
- Minimise energy use and foster utilisation of RES (if needed), coping with potential fluctuations in the energy supply.
- Strong decrease GHG emissions in the overall lifecycle compared to existing waste water treatment processes (or relevant benchmark).

Scope: Energy intensive industry sectors utilise large amount of water in their operations, requiring significant amount of fresh water resources and creating large amounts of waste waters streams. These streams must be further processed requiring significant amount of energy and infrastructure, as well as high investment in capex, operation and maintenance costs. Furthermore, industrial waste waters often contain significant amounts of valuable

substances (e.g. organic matter, salts, phosphates, etc.) and residual heat which are not optimally valorised.

The proposals submitted under this topic are expected to provide innovative concepts for the treatment of industrial waste waters, recovering energy and substances present (metals, organic compounds, nutrients, etc.) fostering reuse of this water in industry, therefore minimising the need for fresh water and moving towards a close loop in industrial water utilisation.

- Proposals are expected to provide integrated technologies to carry out industrial water purification through physical, chemical (and/or biochemical) processes and/or a combination thereof, yielding water streams of appropriate specifications for reuse in industry (same or other industry sectors);
- The technologies proposed should allow maximising the recovery of energy and substances present in the water streams, fostering their valorisation. The technologies proposed should minimise the energy consumption (compared to existing processes) and be able to work efficiently in a renewable based energy system, coping with potential fluctuations in energy supply;
- Replicability/applicability of the proposed solutions in different industry sector should be considered, along with the possibility to achieve integrated cross-sectorial waste water treatment concepts;
- Demonstration of the improved environmental footprint of the proposed processes, as well as other positive impacts should be provided using relevant methodologies (e.g. LCA, LCSA, etc.). The prevention of upcycling of hazardous substances and pollutants (e.g. micro and nano particles, heavy metals, organic substances) should be considered as well as their separation and disposal;
- The proposals are expected to prove the relevance of the proposed approaches and their applicability in existing European industrial and/or urban/industrial contexts;
- Elements related to the replicability and scalability of the technology should be provided;
- Demonstration of the proposed concepts in an industrially relevant environment and at an appropriate scale are expected. The integration of the proposed technology in existing value chains and industrial realities would be an added value;
- Proposals should consider the development of learning resources for the current and future generations of employees, with the possibility to integrate them in existing curricula and modules for undergraduate level and lifelong learning programmes.

This topic implements the co-programmed European partnership Processes4Planet.

Integration of Renewables and Electrification in process industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-15: New electrochemical conversion routes for the production of chemicals and materials in process industries (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3-4 and achieve TRL 5-6 by the end of the project – see General Annex B.

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

- Electrification of the industrial production process;
- Efficient integration of renewable electricity to drive the conversion process;
- Significant reduction of CO₂ emissions of the industrial process;
- Energy savings compared to the classical production routes;
- Overall material savings (waste reduction) compared to the classical production routes;
- Competitive costs of the new process technology and its integration in the processing line, including upstream and downstream.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Renewable electricity will play a major role in the transition towards a low carbon energy supply. The production of chemicals, bulk materials and metals through the direct use of renewable electricity and energy sources can be realised by electrochemical conversion in photo- and/or electro-catalytic processes. Besides the reduction of CO₂ emissions, other advantages of electrochemical conversion with renewable electricity can be the higher selectivity, process flexibility, or the possibility of accessing chemical pathways unattainable in a conventional reactor. Furthermore, photoelectrocatalysis (PEC) directly uses the solar

radiation to drive the electrochemical reaction, enabling potential higher efficiencies and lower costs.

At present, there are promising electrochemical routes towards a wide range of products in process industries. These include processes like hydrogenation of biomass into valuable chemicals, recovery of metals from waste streams, electrosynthesis of organic molecules, production of lime by electrochemical splitting, electrolytic production of metals, (in-situ) production of hydrogen peroxide or ozone, etc.

Next to the low temperature aqueous electrochemical processes, high temperature electrochemical processes, using ionic liquids or molten salts as electrolytes, offer interesting alternatives to the classical production processes as well opportunities for the development of sustainable technology. Moreover, paired synthesis, where two valuable products are generated through the cathodic and anodic reactions, is an interesting approach to reduce investment costs (per unit product). The integration of PEC technologies removes the intermediate electricity production step, which can make the conversion process more energy efficient. Processes that involve multistep transformations can be improved with a cell design that allows for the selective realisation of complex reactions in a single unit and low-cost downstream processing.

All these novel electrochemical paths need to integrate process design with the development of advanced materials and reactor/cell components.

Proposals should address the following aspects:

- Development of the new electrochemical conversion route towards a product or intermediate of interest for process industries and demonstration at an appropriate scale;
- Optimisation of the reactor design and operation and the electrochemical parameters (mass and charge transfer) towards an improved electrochemical performance (increased Faradaic efficiency, lower overpotential, etc.);
- Optimisation of the reactor design and operation and the electrochemical parameters towards the increased lifetime or reduced cost of the electrochemical reactor components (electrode, electrolyte, catalyst, membrane);
- Development of suitable electrodes and electrocatalyst for the new conversion route towards a high selectivity and performance;
- Efficient integration of renewable energy sources, considering also their intermittency and the possibility to offer demand-response flexibility;
- Integrated process design, including materials and reactor/cell, from the process intensification and cost perspectives;

- Demonstration and validation of the proposed concepts at an appropriate scale under environmental relevant conditions. Industrial feasibility should be proven by techno-economic assessments.

The integration of oxidation and reduction reactions to produce valuable products in one system is a valuable aspect. The use of critical raw materials or toxic materials should be preferably avoided. The circular utilisation of a waste or emission stream as raw material and the use of inert or low carbon impact materials, in general, are positive aspects.

The proposed technology must not target the electrochemical conversion of CO₂ or the production of hydrogen by water splitting, as these subjects are covered in other topics of the Work Programme.

Proposals submitted under this topic should include a safety assessment and a life cycle assessment for the implementation of the developed technologies.

In order to achieve the expected outcomes, International Cooperation is advised, in particular with Japan.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2022-TWIN-TRANSITION-01-16: Modular and hybrid heating technologies in steel production (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Use a wide control range of heating capacity by modular heating technologies such local regenerators, and of hybrid heating, based on both fuel gases from the steel-making process and the incorporation of electricity from renewable sources;

- Integrate fuel cells of alternative coal-based products for non-fossil coke, as well as increased use of non-fossil energy and reactants (e.g. green electricity for heat generation, biomass, green hydrogen) in downstream processes.

Scope: Steel plant gases are partly used internally as heating gases and partly used externally, in nearby power plants, to produce electricity at high cost and high CO₂ load.

These gases could be used in reduction processes (blast furnace or even direct reduction) to reduce fossil carbon use, provided they are well prepared for injection in these processes. This notably includes cleaning, compression, heating and removal of oxidised compounds such as CO₂ and H₂O, e.g. through scrubbing or reforming operations. To make a real difference on CO₂ emissions, all these preparation steps need to be performed using internal resources (by-products, heat) or external but low-C energy sources (e.g. electricity, using plasma torches).

The concepts to be developed under this topic are expected to address one or more of the following areas:

- Development of a flexible, *modular technology* that can easily be scaled up for the stepwise integration of heating technologies in Blast furnaces, Electric Arc Furnaces and Direct Reduction Processes;
- Technologies that target the integration of new materials and gases workflows in existing steelworks, combining exhaust gases from the reduction processes and heat generated in downstream processes to reduce the external requirements of energy.

This topic implements the co-programmed European Partnership on Clean Steel.

HORIZON-CL4-2022-TWIN-TRANSITION-01-17: Integration of hydrogen for replacing fossil fuels in industrial applications (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Significant reduction of CO₂ emissions of the industrial process
- Improved energy efficiency of the industrial process
- Significant reduction of hydrogen fuel needs of the developed process with regards to the current fossil fuel needs
- Competitive costs of the developed technologies

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Hydrogen does not emit any carbon dioxide when used and, when produced with renewable energies, it offers a solution to decarbonise industrial processes, being an important enabler to meet the 2050 climate neutrality goal of the European Green Deal and EU's clean energy transition. Hydrogen can be used as feedstock and energy carrier in energy-intensive industry sectors.

Hydrogen presents an opportunity for EU industry to reduce emissions across a number of sectors. The integration of hydrogen into new production routes, the direct use of hydrogen for heating and the use and production of GHG emission-free hydrogen instead of carbon-intensive hydrogen will be fundamental to decarbonise EU industry across a number of sectors.

In energy-intensive sectors, hydrogen can replace fossil fuels to generate high temperature heat when combusted in furnaces/kilns. If GHG emission-free hydrogen is used instead of fossil fuels, a zero GHG emission heating process could be achieved. As hydrogen burns differently than the currently used fossil fuels, its use involves important changes to the furnaces/kilns or the heating process, such as need of new burners, adjustments in the combustion system, conductive zone of the furnace or the (off-)gas system, need of hydrogen compatible materials.

The proposals should address one of the following aspects:

- Redesign of the heating process for the use of hydrogen as the sole heating fuel, including redimensioning and adjustments of the combustion system, conductive zone of the furnace or the (off-)gas system;
- Modification of the heating equipment and infrastructure required for the use of hydrogen, e.g., new burners and hydrogen compatible equipment materials;
- Integration of measurement and control instrumentation for detection and regulation of fuel gas characteristics and flows;
- Proven economic viability, which will be impacted by several parameters.

Proposals submitted under this topic should include a safety assessment and a life cycle assessment for the implementation of the developed technologies.

Proposals should also take into account cooperation with the Mission Innovation area on Hydrogen.

This topic implements the co-programmed European partnership Processes4Planet.

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DESTINATION 2 – INCREASED AUTONOMY IN KEY STRATEGIC VALUE CHAINS FOR RESILIENT INDUSTRY

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- 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’
- KSO A, ‘**Promoting an open strategic autonomy 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’
- KSO D, ‘**Creating a more resilient, inclusive and democratic European society**, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.

Proposals for topics under this Destination should set out a credible pathway to contributing to the following expected impact of Cluster 4:

- **Industrial leadership and increased autonomy in key strategic value chains with security of supply in raw materials**, achieved through breakthrough technologies in areas of industrial alliances, dynamic industrial innovation ecosystems and advanced solutions for substitution, resource and energy efficiency, effective reuse and recycling and clean primary production of raw materials, including critical raw materials, and leadership in the circular economy.

The COVID-19 crisis has shown that global competitiveness and resilience are two sides of the same coin¹⁴. Resilience is about more than the ability to withstand and cope with shocks; it is an opportunity to undergo transitions in a sustainable and fair way. As the EU gears up to becoming a climate-neutral, circular and competitive economy by 2050, resilience will require paying attention to new vulnerabilities as entire sectors undergo deep transformations while creating opportunities for Europe’s industry to develop its own markets, products and services which boost competitiveness.

Research and innovation will be fundamental to spur industrial leadership and enhanced resilience. It will support the modernisation of traditional industrial models while developing novel technologies, business models and processes. This can enhance the flexibility of the EU’s industrial base, and increase its resilience by reducing EU dependencies on third countries for critical raw materials and technologies.

¹⁴ Annual Sustainable Growth Strategy 2021 (COM/2020/575 final)

In the first Work Programme, topics under Destination 2 ‘**Increased autonomy in key strategic value chains for resilient industry**’ will focus on the need to tackle missing segments in strategic areas and value chains to strengthen the EU’s industrial base as well as boost its competitiveness and strategic autonomy. In addition, it will explore how increased circularity has the potential to increase the strategic autonomy of EU industry through the more efficient use of resources and secondary raw materials.

This will be achieved through R&I activities focusing on four areas key for the resilience of EU industry:

- *Raw materials:* The EU is highly dependent on a few third countries for the (critical) raw materials it needs for strategic value chains (including e-mobility, batteries, renewable energies, pharmaceuticals, aerospace, defence and digital applications). In a context where demand is set to increase¹⁵, these will remain, more than ever, a vital prerequisite for both Europe’s strategic autonomy and a successful transition to a climate-neutral and circular economy. Responding to the Critical Raw Materials action plan R&I activities shall tackle the vulnerabilities in the entire EU raw materials value chain, from sustainable and responsible exploration, extraction, processing, recycling, contributing to building the EU knowledge base of primary and secondary raw materials and ensuring secure, sustainable and responsible access to (critical) raw materials.
- *Advanced materials* that are sustainable by design are needed to meet the challenges of climate neutrality, transition to a circular economy and a zero-pollution Europe, as well as broader benefits in many different applications. While chemical and related materials production is expected to double globally by 2030, this will largely take place outside Europe¹⁶. To overcome its reliance on imports of basic chemicals and related materials, Europe needs to strengthen its capacity to produce and use chemicals in a sustainable and competitive way. In addition, it is necessary to continue work on an ecosystem, based on open innovation test beds (OITBs), which enables the rapid development, uptake and commercialisation of advanced materials. All actions should be guided by sustainable-by-design principles, i.e. environmental and health safety, circularity and functionality.
- *Circular value chains:* to complement the circular technologies in Destination 1, further technological and non-technological elements (such as business models and the traceability of products) are necessary in the transition to novel low-emission and circular industrial value chains.
- *Preparedness of businesses/smes/startups:* European companies, and in particular SMEs, have shown a chronic lagging behind the US and China in the uptake of new, and

¹⁵ For example, demand for rare earths used in permanent magnets, e.g. for electric vehicles, digital technologies or wind generators, could increase tenfold by 2050. See the Commission Communication “Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability”, COM(2020) 474 final.

¹⁶ By 2030, China will likely account for more than half of global production, the EU and US for only one quarter of production (Mid-Century Vision report, Cefic, 2019, and International Energy Agency)

especially digital, technologies. See ATI reports from US and China about technology performance: China: <https://ati.ec.europa.eu/reports/international-reports/report-china-technological-capacities-and-key-policy-measures>; and US: <https://ati.ec.europa.eu/reports/international-reports/report-united-states-america-technological-capacities-and-key-policy>

To achieve these wider effects, unprecedented investments in re- and upskilling are central to supporting the green and digital transitions, enhancing innovation and growth potential, fostering economic and social resilience and ensuring quality employment and social inclusion. This is why activities planned under Destination 6 “A human-centred and ethical development of digital and industrial technologies” will also contribute to the objectives of a more resilient industrial base. Further, as industrial leadership and resilience are two sides of the same coin, activities targeting industrial leadership are a key factor in the EU’s long-term industrial resilience. This is why activities supported under Destination 1 ‘Climate neutral, circular and digitised production’ and Destination 3 ‘World leading data and computing technologies’ that further ensure Europe’s productivity growth and competitiveness are also key to safeguarding its strategic autonomy and resilience.

In addition, activities beyond R&I investments will be needed, in particular in terms of synergies with the European Innovation Council and Pillar III of Horizon Europe given the strong role of SMEs in the development of the innovations planned. Synergies will also be sought to access blended funding and finance from other EU programmes notably under InvestEU; testing and deployment activities under the Digital Europe Programme (DEP); links to the EIT (Raw Materials and Digital KICs); links with the Single Market programme to promote entrepreneurship and the creation and growth of companies and links to the thematic smart specialisation platform on industrial modernisation.

Proposals for topics under this Destination should set out a credible pathway to contributing to **increased autonomy in key strategic value chains for resilience industry**, and more specifically to one or several of the following impacts:

- Resilient, sustainable and secure (critical) raw materials value chains for EU industrial ecosystems, in support of the twin green and digital transformations.
- New sustainable-by-design materials with enhanced functionalities and applications in a wide range of industrial processes and consumer products.
- Leadership in producing materials that provide solutions for clean, toxic/pollutant free environment, decarbonising industry, and safeguarding civil infrastructures.
- Leadership in circular economy that strengthens cross-sectorial cooperation along the value chain and enable SMEs to transform their activities and business models.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

Increased adoption of key digital and enabling technologies in industrial value chains and strategic sectors, paying particular attention to SMEs and start-ups.

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

Call	Budgets (EUR million)Deadline(s)
HORIZON-CL4-2021-RESILIENCE-01	
HORIZON-CL4-2021-RESILIENCE-02-PCP	
HORIZON-CL4-2022-RESILIENCE-01	
Overall indicative budget	

Call - A DIGITISED, RESOURCE-EFFICIENT AND RESILIENT INDUSTRY 2021

HORIZON-CL4-2021-RESILIENCE-01

Conditions for the Call

Indicative budget(s)¹⁷

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁸	Number of projects expected to be funded
HORIZON-CL4-2021-RESILIENCE-01-01	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-02	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-03	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-04	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-05	CSA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-06	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-07	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-08	CSA	Around		

¹⁷ 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 2021 and 2022.

¹⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

		N/A		
HORIZON-CL4-2021-RESILIENCE-01-09	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-10	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-11	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-12	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-13	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-14	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-16	CSA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-17	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-18	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-20	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-24	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-25	CSA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-26	RIA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-28	CSA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-29	IA	Around N/A		
HORIZON-CL4-2021-RESILIENCE-01-30	CSA	Around N/A		

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

HORIZON-CL4-2021-RESILIENCE-01-32	IA	Around N/A		
Overall indicative budget				

General conditions relating to this call

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

Novel paradigms to establish resilient and circular value chains

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-01: Ensuring circularity of composite materials (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- Reuse of composite material and recovery of secondary raw materials with higher value than currently available;
- Reduction of waste sent to landfill and positive environmental impact;
- Creation of new value streams through new technologies with potential for commercial exploitation; new business opportunities and revenue flows for recycling companies, benefiting particularly SMEs which dominate this sector of the market;
- Increased uptake of novel composites materials in industrial applications e.g. enhanced lightweight designs for transport, currently limited due to costs and adherence by industry to environmental legislation and the end of life directive.

Scope: The European composites market size was worth €16 billion in 2018 and is estimated to register an annual growth rate of 7.5% from 2020 to 2025 owing to increasing demand for lightweight materials in various energy intensive value chains such as wind energy or transport. However, composites are difficult to reuse or recycle as available technologies such as high-temperature pyrolysis, and grinding (to be used as filler material) are either not environment friendly or economically unattractive. In addition, the environmental legislation on recycling of end-of-life components and structures will mean that from 2025, for example, 80,000 tons of fibre reinforced polymer composites will have to be recycled every year in Europe. In this context it is imperative that technologies are found to reuse and recycle these materials in a useful and sustainable manner. Furthermore, new solutions should also be envisaged to allow their recycling with very few or no need to separate them without a compromise to downcycling.

Proposals should:

- propose innovative dismantling and sorting systems enabling reuse and functional recycling of complex composite materials;
- develop and integrate novel solutions for a higher reuse of whole products and components (i.e. products' reusability, upgradability, etc);
- develop novel, safe, environment friendly and commercially attractive methods of recycling a wide range of composite materials and reuse of secondary raw materials;
- demonstrate at pilot level the feasibility of reuse and/or recycle approaches of composites and its secondary raw materials, for specific applications;

- develop tools that will enable to demonstrate the circularity and the environmental benefits of the solutions tested.

Where relevant, any solution proposed for the reduction of the content of toxic elements or compounds in the resulting materials should also include the appropriate management of the hazardous substances removed.

In order to achieve the expected outcomes, international cooperation is advised.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-RESILIENCE-01-02: Innovative business models for circular value chains (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Strengthen cooperation along the complete value chain, from supply - process industries, manufacturing, to waste and recycling industries;
- Strengthen flexibility and resilience of new circular value chains during breakdown of industry and classical value chains

Scope: The Circular Economy is increasingly seen as a possible solution to address sustainable development. While a lot of technical progress has already been reached done along value chains, to contribute to more sustainable industries and products, promoting a circular business model depends a lot on the type of collaboration which is often inefficient, since it varies a lot on the type of actors involved in the value chain. In order to ensure circularity along the value chain, the product path has to be clearly specified from the beginning and at each stage of the supply chain. In this context, projects are expected to propose new products that can follow a clear path from the supply until the recycling, closing

the loop to ensure circularity. This new model has to include all stakeholders involved in the value chain to ensure circularity and could be based on smart specialisation. Proposals should:

- Develop integrated cost-benefit simulation tools that, can determine the best utilisation options of recovered waste, used products and components and their reintroduction in the value chain;
- Develop decision support solutions based on the above simulation tools;
- Any simulation should link in data from real processes of the value chain in order to provide a platform for real-world scenario simulation;
- Include clear business model development and a clear path to finance and deployment. Key partners should have the capability and interest in making the developed solution a core part of their business/service model to their clients.

This topic implements the co-programmed European partnership Processes4Planet.

Raw materials for EU strategic autonomy and successful transition to a climate-neutral and circular economy

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-03: Identifying future availability of secondary raw materials (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by boosting domestic production of primary and secondary raw materials, participation to the call is limited to legal entities</p>

	<p>established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

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

- Improve knowledge base of EU and third country secondary raw materials (potential, resource estimation, production and refining);
- Promote the utilisation of specifications of the United Nations Framework Classification for Resources (UNFC) to Anthropogenic Resources approved in 2018¹⁹;
- Facilitate and accelerate commercial exploitation development of EU secondary resource recovery projects EU;
- Support identification of the key factors, including socio-economic factors, drivers and barriers affecting development of a recovery project, and enable comparison of different options and projects;
- Develop reports on future trends in raw materials markets. The trends should be linked with change of demand related to the transition to a low-carbon and circular economy;
- Facilitate identification of supply and demand bottlenecks of future secondary raw materials supply;
- Dissemination and exploitation of projects outputs is tailored for EU institutions, Member States and industry dealing with raw materials;

Actions are expected to contribute to the implementation of the following actions of the EU action plan on Critical raw materials:²⁰

- Develop the EU raw materials intelligence, strategic planning and foresight capacity by 2022;

¹⁹ <https://www.unece.org/energy/welcome/areas-of-work/unfc-and-sustainable-resource-management/applications/unfc-and-anthropogenic-resources.html>

²⁰ COM (2020) 474

- Map the potential supply of secondary raw materials from waste and stock in the EU including its regions and help identify viable recovery project for funding by 2022.

Scope: A successful transition to a climate-neutral, circular and digitised EU economy relies heavily on a secure supply of raw materials. In order to strengthen EU autonomy and reduce over-dependency, we must boost domestic sourcing, both for primary and secondary raw materials.

The action should be based on a common understanding of relevant terms and codes, and develop an understanding of anthropogenic resources and derive the needed aspects for classification of recovery projects and to develop criteria for a transparent, consistent and objective classification, needed to establish a comprehensive resource classification approach.

The action should identify future availability of secondary raw materials based on collection and classification of relevant data and information in a harmonised UNFC format. The action should build on and advance further the work of UNECE – UNFC expert group on Anthropogenic resources regarding the classification of secondary raw materials and the work of H2020 project PROSUM²¹ regarding collection of data and information on secondary raw materials. The action should develop a proposal for EU statistics for secondary raw materials.

The action should be based on a common understanding of relevant terms and codes, and develop an understanding of anthropogenic resources and derive the needed aspects for classification of recovery projects and to develop criteria for a transparent, consistent and objective classification, needed to establish a comprehensive resource classification approach.

The focus is on the following streams of secondary critical raw materials: waste batteries, WEEE, mining waste, slags & ashes, construction and demolition waste and others.

All the data and information generated through these actions should be shared in open formats on a free of charge basis with the European Commission, for its own use and for publication.

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

Actions should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

²¹ <http://www.prosumproject.eu/>

HORIZON-CL4-2021-RESILIENCE-01-04: Developing climate-neutral and circular raw materials (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by boosting domestic production of primary and secondary raw materials, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B. – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by providing advanced solutions for resource efficiency, effective reuse and recycling of secondary raw materials, for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Scale up promising raw materials recycling from end-of-life products technologies

- Develop demonstration pilot showing that raw materials can be produced in an innovative and sustainable way in order to make sure that research and innovation end up on the market,
- Strengthen the competitiveness of the EU raw materials industries, contribute to ambitious energy and climate targets for 2030, minimise environmental impacts and risks, maximise circularity of resources and gain the trust of EU citizens in the raw materials sector.

Scope: Securing the sustainable access to raw materials, including metals, industrial minerals, wood- and rubber-based, construction and forest-based raw materials, and particularly Critical Raw Materials (CRM), is of high importance for the EU economy. Complex primary and secondary resources contain many different raw materials. Their processing, reuse, recycling and recovery schemes are complex and imply different steps, ranging from collection, logistics, sorting and separation to cleaning, refining and purification of materials.

The action should develop and demonstrate innovative pilots for the clean and sustainable production of non-energy, non-agricultural raw materials in the EU from end-of-life products, such as waste electrical and electronic equipment (WEEE), batteries, wood-based panels, multi-material paper packaging, end-of-life tyres, etc., finishing at Technology Readiness Levels (TRL) 6-8.

The action should contribute to building the EU knowledge base of secondary raw materials by feeding into the European Commission's Raw Materials Information System – RMIS.

The action should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

The action should facilitate the market uptake of solutions developed through industrially- and user-driven multidisciplinary consortia covering the relevant value chain and should consider standardisation aspects when relevant. The action should also include the analysis of financial opportunities ensuring the market exploitation and replication of the circular business model behind the developed solutions as new processes, products and/or services.

The action should justify the relevance of selected pilot demonstrations in different locations within the EU (and also outside if there is a clear added value for the EU economy, industry and society).

The action should include an outline of the initial exploitation and business plans (with indicated CAPEX, OPEX, IRR and NPV²²) with clarified management of intellectual property rights, and commitment to the first exploitation. This action should also cover social,

²² Capital expenditures (CAPEX), operational expenditure (OPEX), internal rate of return (IRR), and net present value (NPV)

economical and environmental impacts of recovering value from secondary raw materials in comparison to primary raw materials, making focus on the entire process chain.

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

HORIZON-CL4-2021-RESILIENCE-01-05: Building EU-Africa partnerships on sustainable raw materials value chains (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by boosting domestic production of primary and secondary raw materials, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Steer the development of strategic partnerships for EU-Africa industrial value chains' integration, covering exploration, extraction, processing, refining and recycling (if refining capacity is in place);
- Improve sustainability (especially environmental and social aspects) in the mining and metal recycling sectors in Africa, including its impacts on biodiversity;
- Contribute to eradicating illegal and ethically doubtful supply chains and activities;
- Develop knowledge on raw materials potential in Africa that will facilitate investment and business decisions;
- Reduce EU vulnerabilities in raw materials sourcing;
- Diversify EU supply chains from third countries for raw materials, especially for critical raw materials;
- Contribute to connecting different stakeholders of raw materials value chains, including final users.

The project should build on and explore synergies with previous and ongoing EU funded projects for Africa and existing trustworthy EU and international initiatives, covering raw materials value chains.

Dissemination and exploitation of projects outputs is tailored for EU and African organisations and industry dealing with raw materials.

The action is expected to contribute to the implementation of the following actions of the EU action plan on Critical raw materials:²³

- Promote responsible mining practices through the EU's international cooperation programmes, in particular those related to the sustainable development of the informal sector (Artisanal and Small Scale Mining), which has become of strategic relevance in this field;
- Strengthen the local governance and business environment, together with other institutions and development partners (EITI, OECD, UNDP, WB, and Germany's GIZ). The focus should be on supporting the informal sector, and to promote and disseminate responsible business practices.

Scope: Actions should include:

²³ COM (2020) 474

- An in-depth analysis of critical raw materials potential in Africa and existing processing and refining capacities;
- Mapping and assessing investment opportunities in strategic raw materials value chains in Africa, considering factors as existing potential, availability of infrastructures, good governance and regulatory issues;
- Developing new business models to integrate EU and Africa raw materials value chains, considering horizontal and vertical integration;
- Developing a strategy for integration for EU and Africa value chains for the energy and digital transition;
- Building an EU and Africa business networking with upstream and downstream companies;
- Carrying an in-depth analysis on financial instruments and investment funds and loans available at member state, EU and international levels for the Africa region.

All the data and information generated through these actions should be shared in open formats on a free of charge basis with the European Commission, for its own use and for publication.

In addition, public authorities and civil society organisations should participate actively in project activities to ensure that the processes and outcomes of the R&I align with the needs, values, expectations of society and, when social change, new social practices, social ownership or market uptake are required, social innovation should be encouraged.

HORIZON-CL4-2021-RESILIENCE-01-06: Innovation for responsible EU sourcing of primary raw materials, the foundation of the Green Deal (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains</p>

	<p>and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by boosting domestic production of primary and secondary raw materials, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Improve knowledge base of EU and third country critical raw materials to identify new areas for exploration and resource estimation;
- Promote the utilisation of UNFC and UNRMS reporting standards in the raw materials sector;
- Accelerate development of EU domestic raw materials exploration projects integrating innovative technologies that can form the basis for new EU SMEs;
- Strengthen EU autonomy and ethical sourcing of raw materials by developing socially and environmentally acceptable means of discovery and production of primary critical raw materials.

The action is expected to contribute with intelligence and foresight capability to the implementation of the EU action plan on Critical raw materials²⁴ and to support future foresight work of the Commission related to raw materials.

Scope: Actions should develop new knowledge and conceptual models, supported by innovative technologies to strengthen and secure the EU's supply of primary raw materials by generating:

²⁴

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- better geological understanding of known mineral deposits to identify critical minerals resources and inform discovery of new resources
- new genetic models for ore deposit types that host critical minerals in order to identify areas for exploration, especially in previously overlooked regions
- deploy innovative geological, geophysical, geochemical, and data analysis approaches to elucidate the geological history and structure of targeted areas and to guide more environmentally friendly exploration for critical minerals, limiting impacts on biodiversity.

Actions should also map EU and third countries' primary and secondary raw materials potential and raw materials production and refining capacities in a harmonised form, using UNFC (United Nations Framework Classification for Resources) and UNRMS (United Nations Resource Management System).

Actions should also contribute to improving the awareness of the general public across the EU about:

- the importance of raw materials for a successful transition to a climate-neutral and digitised economy and society; and
- the ensuing need for a secure, sustainable, and responsibly-sourced supply of raw materials, including from domestic sources to strengthen EU strategic autonomy and reduce over-dependence on third countries.

All the data and information generated through these actions should be shared in open formats on a free of charge basis with the European Commission, for its own use and for publication.

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

HORIZON-CL4-2021-RESILIENCE-01-07: Building innovative value chains from raw materials to sustainable products (IA)

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

<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by boosting domestic production of primary and secondary raw materials, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B. – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Develop resilient critical raw materials supply chains for the e-mobility and renewable energy ecosystems and strategic sectors, such as defence, aero-space and ICT;
- Increase the EU raw materials supply capability and added value;
- Create new market opportunities for mineral raw materials sustainably produced in the EU;
- Build innovative value chains establishing a direct link between the raw materials producers and the end-users.
- Create new circular business models with a convincing and quantified socio-economic impact.

Scope: Actions should develop innovative and sustainable technology and business solutions finishing at the level of Technology Readiness Levels (TRL) 6-8 for new high value added and sustainable products with enhanced functional properties based on the EU produced raw materials. The industrially- and user-driven multidisciplinary consortia should cover industry players along the relevant value chains starting from raw materials to products. The focus is on raw materials necessary for the e-mobility and renewable energy ecosystems including battery raw materials²⁵; strategic sectors, such as defence and aero-space; or on critical raw materials²⁶, such as rare earths elements for highly performant permanent magnets.

Green and Sustainable Materials

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-08: Establishing EU wide sustainable-by-design materials community to support embedding sustainability criteria over the life cycle of products and processes (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome: Develop a common understanding of the principles of sustainable-by-design when applied to materials, both products and processes. The challenge is to identify the key dimensions that need to be integrated in a product sustainability performance assessment and enhance a systems approach based on Life Cycle Assessment (LCA) framework. The transition to sustainable-by-design²⁷ is a societal urgency²⁸. It is for example the prerequisite to develop alternative and safer (lower toxicity) plastics, surfactants and metal-based systems, and it is relevant for all types of materials.

The proposals are expected to support the uptake and utilization of the sustainable-by-design strategies by industry, especially SMEs, by contributing to the following outcomes:

²⁵ Reference: BAP??

²⁶ Reference to the list of CRMs2020

²⁷ Sustainable-by-design concept takes a systems approach by integrating safety, circularity and functionality of advanced materials, products and processes throughout their lifecycle. This concept can be defined as a pre-market approach that focuses on providing a function (or service), while avoiding properties that may be harmful to human health or the environment. from a lifecycle perspective.

²⁸ Chemicals Strategy for Sustainability COM(2020) 667 final

- Criteria and guiding principles for sustainable-by-design (i.e. integrating safety, circularity and functionality of advanced materials, products and processes throughout their lifecycle), in line with ongoing international work by OECD and UNEP;
- A permanent structure for long-term operation of established gender balanced and inclusive expert's network by time of project end with the involvement of wider communities engaged, beyond consortium members;
- Broadly supported and periodically updated roadmaps based on state of the art knowledge, identified information gaps and their translation into specific R&D questions and governance needs.

Strengthen collaboration and information exchange between relevant actors along value chains (developers, producers, downstream users) to promote the development and implementation of sustainable-by-design approach. Enhancing ownership and engagement of the society through active collaboration and empowering people and communities as actors of the sustainable-by-design transition.

Scope: Establish an inclusive and self-sustained international gender balanced and inclusive network of experts and stakeholders in the materials community to enable multidisciplinary design processes, map skills mismatches and competence gaps, to enable transition towards an overarching framework in which sustainability is the essential entry point into markets:

- Perform landscape analyses of methodologies that focus on the de novo design, which guides sustainable products and processes and coordinate with the projects from NMBP-16-2020 to fill in the gaps in the current understanding;
- Develop working framework for creation of an expanded safety and sustainability community, with agreement to create a common mechanism to engage, mobilise and bring together diverse stakeholders;
- Map and address sustainable-by-design skills mismatches and competence gaps, and support the enhancing of adequate skills at all levels - including in university programmes, research, industry and among regulators;
- Coordinate other EU-funded projects targeting Sustainable-by-Design materials, in particular: HORIZON-CL4-2021-RESILIENCE-01-11, HORIZON-CL4-2021-RESILIENCE-2021-01-12 and HORIZON-CL4-2021-RESILIENCE-01-13.

Sustainability and life cycle of products and processes have a major impact on and can positively contribute to the health and well-being of our citizens.

The topic is open for international cooperation where the EU has reciprocal benefit.

Resulting projects should establish cooperation mechanisms with relevant international initiatives to align and leverage the extensive experience. Therefore, proposals should foresee a dedicated work package for cooperation and earmark appropriate resources.

HORIZON-CL4-2021-RESILIENCE-01-09: Promote Europe's availability, affordability, sustainability and security of supply of essential chemicals and materials (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Europe needs to strengthen its capacity to produce materials and chemicals in a sustainable and competitive way. Moreover, the recent crisis has shown the importance for Europe's chemical and material industry to increase its flexibility, and to adapt quickly its production capacities to the changing supply needs²⁹.

Projects are expected to contribute to the following outcomes:

- Foster global competitiveness of EU companies. Helping Europe to overcome its reliance on imports of chemicals, in particular for essential products, while boosting Europe's economic and social recovery in the aftermath of the COVID-19 crisis;
- Deliver new modular production concepts for the chemical industry (e.g. base ingredients for pharmaceutical or other essential societal products) that would significantly decrease process development time through the standardisation, modularisation and application of novel process intensification technologies;
- Produce highly efficient, flexible, and stand-alone production units that could be shipped to places where the need would be the highest;
- Enable decentralised and continuous processing of high added value chemicals and materials;
- Improve flexibility in products customisation with a faster response to supply chain/customer demands, creating opportunities of new business models enabled by digital technologies.

²⁹ Chemicals Strategy for Sustainability COM(2020) 667 final

Achieve a significant impact on reducing production costs, design efforts time-to market and logistic efforts.

Scope: Building on the experience gained from flexible production units³⁰ it would be possible to equip base chemicals production containers with modular and standardised units capable to facilitate a swift shift in the final production outcome. The focus on the proposals under this topic should thus be the development of adaptable chemical plants with flexible outputs.

Research and innovation actions within this topic may include:

- Improving flexibility and modularity of the equipment;
- Adaptation of process analytical technologies for modular production, to support process control, automation, predictive maintenance and process coordination;
- Smart equipment in intensified up and downstream processing;
- Increasing safety of fully automatic operations and reducing occupational health related risks;
- Standardisation of modular production concepts, including international standards.

Chemicals and materials play a major role in society, and hence sustainability and life cycle of those products have a major impact on and provide solutions concerning the health and well-being of our citizens.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2021-RESILIENCE-01-10: Paving the way to an increased share of recycled plastics in added value products (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or</i>	Activities are expected to start at TRL 3 and achieve TRL 6 by the end

³⁰ F3 Factory, Copiride and Synflow projects in FP7

<i>Societal Readiness Level</i>	of the project – see General Annex B.
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Expected Outcome: Circularity and the increase of the content of recycled plastics in value added products are central to the European Strategy for Plastics.

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

- Establish EU broadly accepted procedures to control the consistent quality of recyclates; characterise their suitability for specific applications and trace the recyclates back to their origin;
- Deliver a clear approach to prevent some potentially hazardous substances to enter the recycled plastics system;
- Enhancing ownership and engagement of the society through active collaboration and empowering people and communities as actors of the circular plastic transition. At medium term, to fulfil the growing demand for recycled plastic content in market products;
- At a longer term, to pave the way toward recyclable-by-design plastics.

Scope: To allow recycled plastics to be more promptly taken up as raw material for new products there is a need for reliable and standardised procedures to characterise, trace back origin and guarantee the safety of the recyclates. The proposals should address one or more of the following areas:

- Developing standard, robust and easy to use sampling and analysis procedures to ensure consistent recycle quality and safe products. Develop methodologies to establish the degree of degradation of recycled materials and to foresee their end-of-life;
- Developing and standardising methods for traceability. Allow the identification of origin of recycled materials via digital information management, e.g. marking technologies or blockchain;
- Detect and separate legacy additive in the waste stream, and ensure safe recycling of plastics containing such additives;
- Diffusing innovation, developing overarching best practices and build up communities to stimulate demonstration.

Proposals should actively pursue the involvement of all the actors in the value chain from the chemical and material industry, to formulators, recyclers, public authorities and standardisation bodies.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2021-RESILIENCE-01-11: Safe- and sustainable-by-design polymeric materials (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The way plastics are currently made, used and discarded, fails to capture the economic, environmental and societal benefits of a more sustainable approach. Europe produces 25 million tons of plastic waste annually, less than 30% is recycled. Moreover, plastic production, use and disposal may result in the release of chemicals, which may give rise to health and environmental problems. The development of a common understanding and the transition to safe- and sustainable-by-design materials, including plastics, is a societal urgency.

Projects are expected to contribute to the following outcomes:

- Recyclable-by-design polymers with inherent recyclability properties for polymers where nowadays recyclability challenge is high;
- Safer (lower toxicity) plastics, with less reliance on potentially harmful additives;
- Reduced environmental footprint associated with the end-of-life phase of the polymers due to increased recyclability and /or reduced reliance on potentially harmful additives, compared with existing products for similar applications;
- Contribute to the development of safe- and sustainable-by-design criteria and guiding principles and apply them to polymers;
- Identification of priorities for substitution of plastic additives;
- New technologies and business opportunities for recycling industry across EU.

Scope: Thanks to their versatility, polymeric materials are used in a wide range of applications from consumer goods and construction to aerospace. The proposals should focus on:

- The design and development of new recyclable polymer systems substituting/improving nowadays difficult to recycle polymers e.g. PVC, thermosets or multicomponent (multilayer or blend) polymers;
- The design and development of safer plastics with less reliance on potentially harmful additives, e.g. plasticizers. The approach should allow to decrease their health and environmental impact and improve the purity of the secondary raw material and thus the quality of recycled plastic without compromising the material optimal properties and functionality;
- Carrying out an inventory of additives detected in plastics and their function and toxicity;
- Integration of safe- and sustainable-by-design aspects, including safety (toxicity), circularity and functionality of advanced polymeric materials, products and processes throughout their lifecycle.

The proposals, activities and approaches should cover both - specific considerations for the plastics under study, as well as developing overarching best practices that spans broader sectors of safe- and sustainable-by-design plastics. Proposals should involve all the actors in the value chain from the chemical and material industry, to formulators, recyclers and regulators. Areas for research include the intersection between chemicals and waste legislation.

Leveraging the extensive experience from relevant initiatives and aligning with other EU-funded projects targeting safe- and sustainable- by-design materials, in particular under CSA topic HORIZON-CL4-RESILIENCE-2021-01-08, is essential.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2021-RESILIENCE-01-12: Safe- and sustainable-by-design metallic coatings and engineered surfaces (RIA)

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

<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: New metal coating systems, free of toxic substances (e.g. hexavalent Chromium), HREEs (heavy rare earth elements), LREEs (light rare earth elements), and PGMs (platinum group metals). A major challenge is the accumulation of metallic materials over the long term in the environment where they tend to have adverse reactions with the ecosystem. On the other hand, the coatings are needed for preservation of the products to prevent for instance corrosion and (bio)fouling. To ensure safety and sustainability of new metal coatings a systems approach that integrates safety, circularity and functionality of advanced materials throughout their lifecycle is required.

Projects are expected to contribute to the following outcomes:

- At least 2 novel materials with improved (or at least comparable) efficiency as compared to traditional materials, associated with a reduction in metal (CRM) usage of at least 15%;
- Materials modelling, assisted by machine learning and artificial intelligence methods, integrated with safe- and sustainable-by-design models;
- Integration of eco-design and circularity concepts in the design of new metal coatings and provide recommendations for the end-of-life of the new material. This should include integration of REACH requirements in the eco-design development and pre-validation of indicators as well as tests to demonstrate the improved sustainability and reduced toxicity of both final product and production process;
- Innovative strategies for improving recovery, recyclability, purification and re-use products at the end of life. This could include the evaluation of their reusability in other application areas other than initial intended use, requiring lower purity inputs;
- An online or/and standalone decision support tool to guide industry (especially SME) for the implementation of safe- and sustainable-by-design approaches tailored to their needs;
- Integration into the standardisation process and development of a roadmap to achieve full standardisation (of e.g. methods, protocols);
- Contribute to the development of safe- and sustainable-by-design criteria and guiding principles and apply them to metallic coating and engineered surfaces.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Metal coatings are applied, to enhance performance characteristics, such as corrosion resistance, colour, attractive appearance, wear resistance, optical properties, electrical resistance, or thermal protection. Applications range from building & construction and consumer goods to catalytic materials, metal organic frameworks (MOFs) and fuel cells and proposals covering all above areas will be welcome. The optimisation of functionality including sustainability and safety considerations and all aspects on resource utilisation across the materials life cycle is essential. Such materials with desired properties and the corresponding manufacturing processes should be designed with the assistance of *in silico* techniques.

Leveraging the extensive experience from relevant initiatives and aligning with other EU-funded projects targeting safe- and sustainable-by-design materials, in particular under CSA topic HORIZON-CL4-2021-RESILIENCE-01-08, is essential.

The proposals, activities and approaches should cover both - specific considerations for the metal coatings under study, as well as developing overarching best practices that spans broader sectors of safe- and sustainable-by-design materials. Proposals should involve all the actors in the value chain.

In line with the Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2021-RESILIENCE-01-13: Safe- and sustainable-by-design organic and hybrid coatings (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Development of organic coatings, safe- and sustainable-by-design production strategies with enhanced functionality. This includes organic coatings and additives to substitute PFAS type coatings. Due to significant technical and scientific challenges in several areas it has been difficult to find safer alternatives with the absence of hazardous additives. In the past, this has led to substance substitution with compounds that

did not avoid the problem, but minimized it. Instead, a better approach is to cover the whole lifecycle of products and include avoidance of hazardous substances and the programming-in of sustainability along the product life cycle.

Projects are expected to contribute to the following outcomes:

- A set of computational tools (including first-principles-based, data-driven, physics based and hazard, transport and fate models) to be used for supporting Safe- and Sustainable-by Design of materials (e.g. organic coatings and additives to replace PFAS);
- At least 2 novel materials (including bio-based ones) assessed in terms of their performance (function), human and environmental hazards (end-points determined based on the application areas) as well as their carbon and water footprints, recovery and recyclability, and overall environmental impact (LCA). Reaching at least 25% reduction in environmental impacts with <20% cost increase for production;
- Contribute to the development of safe- and sustainable-by-design criteria and guiding principles and apply them to organic coatings;
- Enhance the social acceptance of the new developed materials by evidence basis compiled for consumer attitudes towards, and willingness to pay for, products that are less harmful to the environment, are sustainable, low carbon etc.;
- Certification programme (or equivalents) for sustainable containing products, along the whole value-chain;

Integration into standardisation process and development of a roadmap to achieve full standardisation (of e.g. methods, protocols).

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: The largest share of the organic coatings market belongs to a family containing Polyfluorinated Alkyl substances (PFAS), used in a wide variety of consumer and industrial products. Research will therefore target development of innovative PFAS-free materials with inherently surface active functions to be used for multi-industrial sector applications. (e.g. novel bio-based materials). The proposals should focus on integration of sustainable-by-design aspects including safety (toxicity), circularity and functionality of advanced coating materials (e.g. self-healing or omniphobicity), throughout their lifecycle. Projects should include one or more of the following aspects:

- Materials design supported by in silico methods for predicting hazards (toxicity) and fate to reduce additive exposure/leaching to humans and the environment;
- Development of alternatives maintaining functionality as well as reducing hazard and/or exposure (persistence) profiles with the aid of nanoinformatics modelling in order to reduce animal and experimental testing;

- Development of assays and approaches to demonstrate the reduction of hazard and/or exposure profiles of the new (alternative) advanced materials in a streamlined and robust manner to support route to market.

Leveraging the extensive experience from relevant initiatives and aligning with other EU-funded projects targeting safe- and sustainable- by-design materials, in particular under CSA topic HORIZON-CL4-2021-RESILIENCE-01-08, is essential

The proposals, activities and approaches should cover both - specific considerations for the organic coatings under study, as well as developing overarching best practices that spans broader sectors of safe- and sustainable-by-design materials. Proposals should involve all the actors in the value chain.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

Materials for the benefit of society and the environment and materials for decarbonising Industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-14: Development of more energy efficient electrically heated catalytic reactors (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: A shift from fired- to electrically-heated catalytic reactors, powered by renewables will lead to a large decrease in CO₂ emissions, coupled with a significant process intensification. As currently reactors are kept at high target temperatures in industrial-scale catalytic processes with energy supplied by the combustion of fossil fuels, substitution of fossil-fuel-derived heating with an emissions-free alternatives will substantially contribute to the greening of large industries. This requires the re-design of the reactor and in parallel with

the development of novel catalysts as well as integration of up and downstream processes to operate with optimal energy efficiency and product yield.

Projects are expected to contribute to the following outcomes:

- A breakthrough reduction in carbon footprint for a given reaction (CO₂ emission reduction > 40%, demonstrated by LCA or similar studies);
- Demonstrate a significant process intensification (a reactor size reduction of > 50% with respect to the state-of-the-art conventional approach) and industrial scalability;
- Environmental and techno-economic feasibility of novel catalytic reactor technologies and catalyst materials demonstrated and validated at suitable scale against current industrial processes to produce the same products;
- Integrated development methodology of catalysts and reactors for an optimized design up to pilot unit of novel catalytic reactors with significant carbon footprint reduction and allowing relevant process intensification, while maintaining cost competitiveness;
- Advanced catalytic reactor concepts to operate in synergy with alternative energy resources like e.g. non-thermal plasma.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Proposals should address an integrated development of:

- The next generation of industrially scalable and robust reactor technologies and associated catalytic materials for an electrified chemical production with an optimized design, up to pilot unit;
- Environmental and techno-economic impact studies should be part of the objectives to demonstrate the industrial feasibility and integration within the value chain of production and use of renewable energy sources.
- Solutions allowing the combined use of renewable energy resources with process intensification should be investigated in order to optimise energy efficiency, product yield and purity as an integrated part of the total process.

The topic is open for international cooperation where the EU has reciprocal benefit, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed.

HORIZON-CL4-2021-RESILIENCE-01-16: Creation of an innovation community for solar fuels and chemicals (CSA)

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome: Creation of an innovation eco-system gathering the various elements necessary to accelerate the development in the area of introduction of solar fuels and chemicals. This will require a strict synergy of actions between all stakeholder components, from R&D to industry and society, in order to foster their introduction. In addition, the development of solar fuels and chemicals requires a full redesign of the current technologies and processes based on fossil fuels, and the technological gap is a main factor limiting their introduction.

Projects are expected to contribute to the following outcomes:

- Solar fuels and chemicals constitute those products that are equivalent in terms of functionality to the ones currently in use based on fossil fuels, and thus well integrating within the existing infrastructure, but produced with the aid of renewable energy sources and with a disruptive decrease in terms of reduction of greenhouse gas emissions on LCA bases, larger than that based on biomass sources. They will play a crucial role to meet targets for decarbonizing Europe;
- Structuring/developing in the short term the European ecosystem in order to speed up technologies to move from the laboratory to industry;
- Tackle long-term research challenges in the field. This would be done mainly through the RIA & IA topics of the large-scale R&I initiative, as well as with actions at national and regional levels, with overall coordination by the CSA.

Scope:

- Coordinating a large scale R&I initiative on storage of renewable (solar) energies in chemical form involving all relevant stakeholders (from academia, RTOs, industry and society) and linked with relevant international, national and local programmes and initiatives;
- Building and updating, a long-term roadmap;
- Building/structuring a gender balanced, inclusive community with all relevant stakeholders across EU;
- Participation of societal stakeholders to the activities of the community and initiative;

- Facilitating cooperation and communication between the stakeholders of the initiative on cross-cutting topics;
- Strengthening the engagement of the European industrial stakeholders in the long term beyond the CSA;
- Creating an innovation eco-system to foster and accelerate the technological, economic and societal impact of the initiative and pave the way to industrial exploitation of the technologies in the field of energy, transport and climate;
- Speeding-up and increasing the positive impacts of technologies on climate change and protection of environment;
- Spreading of S&T excellence across Europe and increase awareness of European activities;
- Addressing international cooperation in particular with other relevant actions (e.g. Mission Innovation);
- Preparing a large-scale research and innovation initiative beyond the CSA, as a partnership or another instrument to be discussed and agreed upon with the Commission and the Member States and Associated countries.

The topic is open for international cooperation where the EU has reciprocal benefit.

HORIZON-CL4-2021-RESILIENCE-01-17: Advanced materials for hydrogen storage (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The benefits of a hydrogen based economy are well documented, since hydrogen is an abundant zero emission fuel, and possesses a higher energy density than conventional fossil fuels (e.g. petrol). However, safe hydrogen storage, either long or short

term, faces several challenges. Chemical storage, fuel cells and liquefaction are all current means of hydrogen storage. Chemical storage is the prevailing method for long term storage due to the high storage density but the synthesis process needs further development to make it commercially attractive. Pressurised gaseous storage is the most attractive in practical terms but compression up to 700bar is needed to achieve practical volumetric storage capacities for transport applications, which requires expensive pressure vessels and is inherently dangerous. However, new approaches using ultra porous materials have demonstrated the feasibility of high storage densities of gaseous hydrogen at pressure of 100bar.

Projects are expected to contribute to the following outcomes:

- Provide commercially attractive and safe new technologies for long-term storage and transport of hydrogen;
- Enable efficient and safe hydrogen short term storage for example for fuel tanks for automobiles, rail vehicles, ships, etc., eliminating pollution caused by fossil fuels and facilitating the greening of transport;
- Elimination of economic dependence for EU's energy needs;
- Ability for distributed production, providing opportunities for new business ventures and the development of new centres for economic growth in both rural and urban areas that currently find it difficult to attract investment in the current centralised energy system.

Scope: Research proposals should address at least one of the following:

- Development of new environmentally friendly catalysts for ammonia synthesis at low pressures for long term hydrogen storage and distribution;
- Development of new ultra porous materials for hydrogen storage with a gravimetric storage capacity in excess of 6 wt% and a volumetric storage capacity in excess of 40g/lit. The use of machine learning techniques to assess combinations and substitutions in various porous materials to help optimise the development process should also be considered;
- Development of suitable pressure vessel materials for the containment of the adsorbent ultra-porous materials;
- Conduct full LCA of the new developed materials, (catalysts, ultra-porous materials) and processes (synthesis process, ultra-porous material production);
- Produce a demonstrator plant for low pressure ammonia synthesis;
- Produce a demonstrator pressure vessel containing ultra-porous hydrogen adsorbents.

The topic is open for international cooperation where the EU has reciprocal benefit, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed.

HORIZON-CL4-2021-RESILIENCE-01-18: Novel materials for supercapacitor energy storage (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Supercapacitors are attractive alternatives to batteries because they can be charged very quickly and can sustain vastly greater number of re-charge cycles than batteries without losing efficiency. However, their power energy is lower than that of batteries but recent material research breakthroughs have indicated that this can be substantially increased. Projects are expected to contribute to the following outcomes:

- New supercapacitors with energy densities comparable to batteries in environmentally friendly electrolytes able to recharge in a fraction of the time required for current batteries, have no loss of performance over time and longer life;
- Substantial impact to energy storage systems solutions for applications ranging from consumer goods to electrification of transport and reduction of emissions;
- Innovative management systems for supercapacitors;
- Establish new industrial value chains with new energy storage products, tailored to meet the application requirements.

Scope: Compared to batteries, supercapacitor energy density is low and they use more expensive and critical raw materials (CRMs). Proposals should address the challenge for new material concepts to be used in supercapacitors to at least double the energy density over current technologies reduce cost and minimise or eliminate use of CRMs.

The topic is open for international cooperation where the EU has reciprocal benefit, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed.

HORIZON-CL4-2021-RESILIENCE-01-20: Antimicrobial, Antiviral, and Antifungal Nanocoatings (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: The recent outbreak of the COVID19 virus has demonstrated that costs in both human life and economic terms can be immense if measures are not in place to contain a spread of infection. It is apparent therefore that passive measures are in place to minimise the impact of current and future infection outbreaks. Nanoparticle filled coatings such as metal nanoparticles, carbon nanotubes, metal oxide nanoparticles, heterostructures, patterned surfaces and graphene-based materials have demonstrated up to 99.9998% effectiveness against bacteria, mould and viruses.

Projects are expected to contribute to the following outcomes:

- Minimise the risk of spread of infections from harmful pathogens arising from everyday human activities;
- Create a healthier living and working environment and offer holistic solutions to people with a diminished immune system;
- Improve citizen health and enhance the EU's reputation as a public health best practice region;
- Enhance economic benefits through reduction of lost hours of work through illness;
- Boost research, development and innovation in the EU;
- Provide business opportunities especially for SMEs;
- Sustainable synthesis of nanocoatings (including bio-based materials) especially with effectiveness against a range of pathogens.

Scope: Inorganic nanomaterials have demonstrated enhanced anti-microbial and anti-viral activity. They are also stable at high temperatures, robust, and have a long shelf life, compared to organic anti-microbial coatings. Research areas should address new antiviral and antibacterial nanocoatings for a range of applications addressing use on both surfaces of so-called high-traffic objects (e.g. door and window handles in public places, hospitals, public buildings, schools, elderly homes etc) and coatings for textiles (e.g. protective clothing in food processing plants, laboratory coats, face masks, etc.).

The research should address the following aspects:

- Sustainable synthesis of nanocoatings/nanocomposites (including bio-based materials) with effectiveness against a range of pathogens;
- Application methods (both on surfaces and textiles);
- Surface adhesion and durability via assessing performance against wear (e.g. abrasion, washing, etc.) and degradation in the application environments on a variety of surfaces (e.g. glass, metals and various alloys, copper and steel, marble and stone slabs, ceramics and tiles, textiles and plastics);
- Toxicity of nanocoatings.

This topic is directly related to the well-being of citizens in the context of COVID-19 virus pandemic.

Materials and data cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-24: Optimized Industrial Systems and Lines through digitalisation (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B. – see General Annex B.

Expected Outcome: The digital transformation of the European manufacturing industry depends on the availability and uptake of high quality, efficient, affordable and optimised systems, such as those offered by cloud infrastructures, simulation-based twin technologies, data driven approaches. However, there is a low uptake in Europe for such technologies, for example in the case of cloud computing only 1 company in 4 apply it and only 1 in 5 for SMEs³¹.

Projects are expected to contribute to the following outcomes:

- Support the transition towards industrial digitalisation;
- Increase speed of innovation by optimising the use of existing research results and facilitating uptake of new projects results;
- Design digital tools for industry (e.g. cloud systems, simulation-based twin technologies, data driven approaches, AI-based and reinforcement learning solutions) to enhance efficiency and product quality, as well as to increase the capability for better and faster reaction to market changes;
- Contribute to the development of advanced material modelling solutions in particular for manufacturing industry;
- Enhance data interoperability and new type of services related to the data analysis, simulations and/or visualisation techniques in each stage of the material value chain (design, processing, manufacturing, etc.) using FAIR data principles.

Scope: Digital tools can enable industry to control manufacturing processes and address issues more efficiently and effectively as they run and update the production plant, while improving key product and production performance indicators such as yield and throughput.

Proposals under this topic have to

- design robust digital tools integrating materials modelling and materials process development for industry;
- promote use and adaptation of existing tools and process developments that are applicable to different sectors;
- contribute also to the development of simulation and optimisation methods to facilitate more efficient design space exploration via experimentation, thereby reducing physical testing and improving quality;
- enhance efficiency of the manufacturing process;
- improve process and product quality;

³¹ https://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises.

- improve decision making efficiency, quality and understanding, while at the same time maintaining low operational costs.

Interconnection between processes and other industries is also in the scope, as there is an increased integration of different domains and disciplines in complex workflows. To overcome the problem, proposals have to address interoperability by implementing available data standards like MODA, CHADA and ontologies like EMMO, as well as cooperation with the Industry Commons developments.

The proposed use cases for the developed tool should demonstrate the business case and how more sustainable solutions are achieved in the market, for example by reducing waste and/or emissions during production. A Life Cycle Assessment should be included to estimate the environmental improvement, together with a Life Cycle Cost assessment to demonstrate the lower operational costs.

HORIZON-CL4-2021-RESILIENCE-01-25: Biomaterials database for Health Applications (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Create of a database of biomaterials, providing detailed information on the chemical-physical, biological and toxicological properties accessible to wide variety of end-users, for e.g. researchers, companies and clinicians for the purposes of evaluating the biological and clinical usefulness also in the areas beyond their intended primary applications.

Scope: Projects will incorporate data on as many of the material properties as possible, allowing for the development of standardised protocols for the determination and measurement of the efficacy and safety of new biomaterials, taking into account the specificities due to sex, race and age, whether they be single or combination entities. Processing of data should be done in accordance with GDPR provisions.

A label of biocompatibility should be established so as to define the suitability of a biomaterial for eventual use in a Medical Device or Advanced Therapy that the biomaterial

becomes a part of, so as to assist companies, especially SMEs, in choosing and facilitating market access for their products.

This database should also contain comparative analyses of the results of biological testing of biomaterials from the scientific literature (and clinical trials, where possible) so as to incorporate data on as many of the material properties as possible, incl. taking into account the specificities defined by sex, race, age. Based upon this, it should be possible to formulate, as necessary, standardised protocols for the determination and measurement of the efficacy and safety of new biomaterials, facilitating as it will, the need to establish high throughput test platforms in the future for biomaterials, that comprise standardised testing protocols for ex vivo, in vivo, pre-clinical and clinical testing.

Proposals must also address all the areas below:

- Develop a user-friendly platform for making all relevant data easily and readily accessible for the assessment and decision-making processes in appropriate formats to ensure interoperability. To ensure that the data are processed in accordance with the GDPR provisions;
- Facilitate extracting, analysing and re-using of the data with advanced data processing technologies e.g. Artificial Intelligence;
- Provide innovative trainings and manuals for the use of the database and its documentation;
- Develop a business model for the maintenance of the database demonstrating its sustainability beyond the funding period.

Proposals submitted under this topic should include actions designed to facilitate cooperation with other projects; to enhance user involvement; and to ensure the accessibility and reusability of data produced in the course of the project by agreeing on metadata for the description of the materials databases.

HORIZON-CL4-2021-RESILIENCE-01-26: Sustainable Industry Commons (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 6 or more by the end of the project – see General Annex B.
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Expected Outcome: Data has an enormous economic impact and yet, only a small share of industrial data is retained and used for value creation. European industry needs solutions to mitigate the barriers for industrial data reusability and facilitate the unlocking of value from data, which will make a significant difference to the performance and competitiveness of European industry. At the same time, the efforts to make European industry more competitive and innovative need to be achieved without compromising the future of forthcoming generations, therefore it is also important to provide European industry with tools that aid them in improving their sustainability.

Projects are expected to contribute to the following outcomes:

- Develop tools to support industry in sustainable production and consumption of goods, which assist to improve the overall sustainability performance and contribute to the development of more sustainable solutions by embedding circular economy strategies;
- Develop ontology based data documentation for the application domain to facilitate interconnection by data exchange between designers, manufacturers, users and collectors of used/waste products, applying FAIR data principles and taking into account the specificities due to sex, race, age, religion. The data should be processed in accordance with GDPR provisions;
- Reinforce European industry capacities and adapt to the new trends in the areas of sustainability and digitalization, and contribute to the development and/or creation of standards;
- Increase competences for data handling among the potential data users (e.g. by providing trainings).

Scope: To develop tools for industry to enhance efficiency and contributing to less waste and emissions while improving material/product/process quality all along the lifecycle of a product/service system. The proposals should have a holistic approach, with a minimum of three demonstrators/use-cases, covering the entire material/product/process life cycle and proving the interoperability of data across the life cycle stages across industry domains. The developed tools have to be compliant with existing standards, and the proposals should contribute to development and/or creation of new ones.

The developed tools have to address circular economy strategies (as for example improvement of durability, reusability, recyclability, recycled content, product reparability, etc.) in order to guide companies to the development of their sustainability agendas with an effective and user-friendly interface. Improvement of the overall environmental performance should be demonstrated applying Life Cycle Assessment.

The developed tools have to be semantically interoperable and associated application domain ontologies and data format have to be built upon the emerging developments of the Industry Commons projects of H2020. Actions designed to facilitate cooperation with other projects, to enhance user involvement and to ensure the accessibility and reusability of data produced in the course of the project should be addressed.

Improving the resilience and preparedness of EU businesses, especially SMEs and Startups

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-28: Re-opening industrial sites preparatory action – Promoting a sustainable strategy for Europe’s industrial future (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Providing strategic business development plans for the re-opening of more than 20 industrial sites in Europe, which have recently been closed or are about to be closed in the next months;
- Proposing networks of key players, stakeholders and projects to support regions exploring new approaches to address the challenges of green and digital transition of industries, an innovation-led and place-based approach inherent in Smart Specialisation, building on the specific assets and resources of each individual region concerned, supporting regional entrepreneurial culture, infrastructure and innovators;
- Analysing the regional cross-fertilization potential between traditional, high-tech and digital sectors, education and research, federal and local authorities, early stage venture capital and innovators;
- Promote the establishment of a new sustainable and inclusive regional industry ecosystem;
- Identification of innovation barriers and recommendations for policy support;

- Analysis should be based on key figures like: Economic growth rates and Per Capita GDP, salaries; labour and unemployment rate of different population groups; innovation power in terms of patent applications; number of business registrations per year; tax revenues, taking also into gender and demographic data.

Scope: European innovation policy must place a greater emphasis on promoting innovation in less-developed regions to trigger economic recovery in regions the local economies and societies suffered from the recent closing down of industrial plants and sites, which had once offered lots of jobs in these regions and has thus ensured a level of prosperity for the local population.

Aiming at achieving a sustainable and inclusive industrial transformation, Europe needs to develop new industrial policies relaunching productivity growth in regions suffering most from COVID-19 and economic situations of radical change. This will also help to achieve a competitive social market economy in Europe that seeks to guarantee a balance in living standards and economic conditions between urban and rural areas as well as regions.

The objective of this coordination and support action is to analyse the industrial ecosystem of more than 20 regions in Europe and how they could be influenced by comprehensive industrial policies, innovation programs, private investments accompanied with modern regional administration policies and public investment in infrastructures, both digital and transportation. Focus is both, on the growth of the digital industries, and on the transformation of traditional industries and the creation of new business opportunities that could offer the potential for a long term value creation and for new jobs.

The coordination and support action should network the stakeholders across entire innovation value-chains and regional development programs. A holistic approach is needed, mobilizing a diverse set of players from private and public organisations. The translation of an industrial revitalization into integrated business development solutions across disciplines should be envisaged and sustainable and inclusive regional-specific business development strategies should be proposed to be taken up. In particular, the key actors in the region, who have a “gravitational pull” should play a key role should be identified and involved.

The interplay between large companies and the start-up scene, authorities and financial organisations are important success factor for a region. The strength of the industrial innovation ecosystem should be summarised by characteristics such as robustness, diversity in particular in terms of age, gender, ethnicity, cross-fertilisation between sectors, large and small companies spurring the ecosystem, entrepreneurial culture, well connected across the world, openness to disruption, platform-economy, supportive state, public procurement and education and acceptance by the local population.

HORIZON-CL4-2021-RESILIENCE-01-29: 'Innovate to transform' support for SME's sustainability transition (IA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Support objectives of the European Green Deal and of the EU SME Strategy for a sustainable and digital Europe;
- Increased resilience of SMEs, by fostering technological and social innovation in SMEs to support their transition to more sustainable business models and more resource-efficient and circular processes and infrastructures;
- Increased competitive sustainability of SMEs through the uptake of advanced technologies;
- Stronger innovation support ecosystems supporting the green, social and economic transition of SMEs, by leveraging synergies between existing EU networks and SME support initiatives.

Scope: Achieving European Green Deal objectives, and notably a climate neutral and resource efficient economy, requires the full mobilisation of SMEs. The COVID-19 pandemic has also led to companies redesigning their supply chains and facing a new industrial revolution, brought on by a new generation of advanced technologies³², which are underpinning the potential for competitive sustainability of SMEs.

The action will build on and further connect existing EU specialised business support networks and centres - such as the Enterprise Europe Network, the European industry clusters registered under the European Cluster Collaboration Platform, Centres for Advanced Technologies for Industry. They will work in complementarity and close interaction with Open Innovation Test beds, European Digital Innovation Hubs, Start-up Europe, etc, but also with academia, social partners and other social innovation actors.

³² The Advanced Technologies for Industry project of the European Commission offers analytical overview of 16 advanced technologies: <https://ati.ec.europa.eu/about/what-is-ati> : *Advanced Manufacturing Technology, Advanced Materials, Artificial Intelligence, Augmented and Virtual Reality, Big Data, Blockchain, Cloud Computing, Connectivity, Industrial Biotechnology, Internet of Things, Micro- and Nanoelectronics, Mobility, Nanotechnology, Photonics, Robotics and Security*. European SMEs have shown a chronic lagging behind the US and China in the uptake of advanced technologies - See ATI reports from US and China about technology performance: China: <https://ati.ec.europa.eu/reports/international-reports/report-china-technological-capacities-and-key-policy-measures>; and US: <https://ati.ec.europa.eu/reports/international-reports/report-united-states-america-technological-capacities-and-key-policy>

Organisations in these EU business support networks and centres are expected to team-up and join forces as partners in transnational consortia at least 3 partners from 3 different EU Member States and Associated Countries.

This action will consist in:

A. Advisory services

Dedicated innovation and capacity building support will be provided to SMEs, to assess their ability to transform their business models and increase their resilience.

This will consist of an assessment of SMEs' innovation and sustainability practices, elaboration of recommendations, notably in view of the uptake of advanced technologies and/or social innovations.

Based on these recommendations, SMEs could receive further advisory services according to their level of preparedness such as help and advice on proof of concept, investment readiness, intellectual property rights, technology transfer, adaptation to standards, adaptation to environmental rules, design management, skill development, partner search (including social partners). SMEs will receive targeted assistance for the uptake of advanced technologies.

Social innovation should be recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

This action will also include the set-up of a community, building on the SME Alliance projects, in which best practices should be exchanged and SMEs could benefit from dedicated peer-learning activities in order to learn from leaders (SMEs or larger corporates) of their own sector. Incentives for leaders to share their best practices with peers should be identified in the context of EU support to industrial ecosystems.

B. Financial support in the form of 'Third party financing'.

As a result of the advisory services and initial assessments, SMEs will receive financial support of up to 50.000 EUR, to implement the elaborated recommendations. The financial support will be provided in the form of 'Third party financing' calls for SMEs. It will be channelled through the selected transnational consortia mentioned above.

This should support amongst others the financing of a feasibility study, prototyping, pilot testing, demonstrating, procurement of further specialised consultancy services and coaching services that cannot be provided directly by the project partners, adaptation of business processes, free access and support to use testing facilities, introduction of new IT solutions etc.

HORIZON-CL4-2021-RESILIENCE-01-30: SMEs' Green Innovation Associate (CSA)

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Support objectives of the European Green Deal and of the EU SME Strategy for a sustainable and digital Europe;
- Increased resilience and increased innovation capacity of SMEs by acquiring new expertise and skills to support their efforts to adopt new sustainable products, processes, services or business models;
- Turning creative business ideas into concrete innovations contributing to Green Deal goals.

Scope: This innovation capacity building action will provide a grant at European level to visionary³³ SMEs that can demonstrate that the skills required for a particular innovation idea supporting the goals of the Green Deal³⁴ – and in particular their efforts to adopt new sustainable products, processes, services or business models - are not within reach for them at national level (for example because the required skills are not available or not affordable for SMEs).

SMEs are supported to employ a highly skilled experienced researcher (referred to as an 'innovation associate') for a continuous period of one year. The innovation associate's task

³³ Vision: 'A statement about what the organisation wants to achieve in terms of innovation. The vision should set a direction and a challenge that can inspire persons to commit and work towards, be sufficiently ambitious and not constrained by the organisation's current abilities, provide a target against which progress can be measured.' See Innovation management standard CEN/TS 16555-1 (July 2013)
Defined for the purpose of this action as : Increasing the EU's climate mitigation and/or adaptation ambition; Supplying clean, affordable and secure energy; transitioning of industry to a clean and/or circular economy (including waste prevention and/or recycling); building and renovating in an energy and resource efficient way; accelerating the shift to sustainable and smart mobility; transition to a fair, healthy and environmentally-friendly food system; preserving and restoring ecosystems and biodiversity and realising a zero pollution ambition and a toxic-free environment

³⁴ Vision: 'A statement about what the organisation wants to achieve in terms of innovation. The vision should set a direction and a challenge that can inspire persons to commit and work towards, be sufficiently ambitious and not constrained by the organisation's current abilities, provide a target against which progress can be measured.' See Innovation management standard CEN/TS 16555-1 (July 2013)
Defined for the purpose of this action as : Increasing the EU's climate mitigation and/or adaptation ambition; Supplying clean, affordable and secure energy; transitioning of industry to a clean and/or circular economy (including waste prevention and/or recycling); building and renovating in an energy and resource efficient way; accelerating the shift to sustainable and smart mobility; transition to a fair, healthy and environmentally-friendly food system; preserving and restoring ecosystems and biodiversity and realising a zero pollution ambition and a toxic-free environment

will be to explore, during the course of his/her contract, the potential of their innovative idea and turn it into an innovation project, supporting the SME's transition to sustainability.

This enterprise-led mobility programme builds upon the 'Innovation Associate' pilot launched under the Horizon 2020 Work Programme "Innovation in SMEs", and complements Marie Skłodowska Curie actions (MSCA) by focussing on SMEs needs.

The evaluation of proposals will focus on the demonstrated benefits of recruiting transnationally i.e. the impact for the SME to get access to skills not available on the national labour market; the excellence and impact of the innovative idea, its contribution to the Green Deal goals as well as the coherence and effectiveness of the recruitment plan, which should offer the same opportunities for male/female candidates.

SMEs that will receive a grant will be obliged to advertise their vacancy on EURAXESS, unless a contract with an innovation associate has already been signed in line with the provisions above. They are also encouraged to publish the vacancy notice on any other relevant platform or media, with a clear indication that the grant was awarded.

The innovation associate's tasks are to identify the potential of the company's innovation idea with the objective and turn it into an innovation project and - hopefully - a continuation of the employment of the innovation associate. During the period covered by the grant, the Innovation Associate must work exclusively on the project described in the grant agreement.

In line with the orientation of the action and with the aim to accelerate the integration of the associate in the company's staff, the following costs are eligible for reimbursement under the grant:

- Personnel costs of the associate;
- Relocation costs of the associate, which may include removal cost, travel cost of the associate and his/her immediate family (if applicable) to the new place of employment, visa cost (if applicable), translation cost of certificates (if applicable), a temporary transition allowance to cover extra costs upon arrival in the place of employment, cost for the relocation in the country of origin after the project, as well as other clearly justified expenditure directly related to relocation;
- Travel and subsistence costs of the associate to the core training programme and travel and subsistence for tailored training (as described in the personal development plan). Travel cost and subsistence for the supervisor may be eligible for up to two training sessions;
- Travel and subsistence cost for the innovation associate and the supervisor in the enterprise to one kick-off meeting in Brussels (one day), organised by the European Commission³⁵.

³⁵ The organisation of such a meeting is subject to confirmation by the European Commission at a later stage.

Personnel cost may include allowances that are in line with the beneficiary's standard practices (for example child education or housing allowances).

Other costs like recruitment costs, equipment costs or travel costs to action-specific workshops by the supervisor in the enterprise are covered by the flat rate indirect cost.

Any cost not directly related to the employment and training of the innovation associate - for example cost of research, dissemination or promotion activities and other cost relating to the actual implementation of the innovation idea/project - are not eligible under this call.

This topic will take the form of lump sums as defined in Commission Decision C(2017)7151 of 27 October 2017. Details of the lump sum funding pilot scheme are published on the Funding & Tenders Portal together with the specific Model Grant Agreement for Lump Sums applicable.

The following criteria will have to be met by the associate: i) PhD holder (or equivalent), ii) an expertise in line with the job requirements as outlined in the vacancy notice; iii) compliance with transnational mobility criteria as defined in the mobility rule of the Marie Skłodowska Curie Actions (MSCA)³⁶.

SMEs can only receive one grant for the whole duration of this topic.

The preferred start date of the innovation associates' employment is in September of the year following the call opening in order to align the timing of the action with the academic year. The execution of the action will start on the starting date of the associates' employment (exact date to be determined during the grant preparation phase).

The innovation associates are expected to be offered employment contracts or equivalent by the hosting SMEs. In return, the innovation associates must commit to a full-time position, for the full duration of the grant.

HORIZON-CL4-2021-RESILIENCE-01-32: Demonstrating innovative practices for renovation in social and affordable housing districts (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

³⁶ Reference to the MSCA mobility rule will be provided at call opening.

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

- Demonstrate renovation pilots in the sense of “*lighthouse districts*” as announced by the *Affordable Housing Initiative*: pilot lighthouse renovation districts in a smart neighbourhood approach and provide blueprints for replication, setting liveability and latest technological and social innovations at the forefront;
- Mobilise cross-sectoral industrial³⁷ and Public Private Partnerships (PPP’s) at local level to develop, adapt, design new processes, methods and technologies (e.g. energy efficiency, circular, modular building, smart living, eco-design,...). Special attention should be paid to the needs of residents in social using, through social innovation and using a human centred approach;
- Following a multi-actor approach, as defined in WP/ Annex X, engaging both, different sectors and fields of operation related to construction such as renewable energy, water treatment, and electronics as well as residents, social and public housing associations and civil society actors will be key to boost tailor-made and fit for purpose innovation;
- Demonstrate through such partnerships *lighthouse districts* that allow integrated renovation approaches. Besides technological innovation, specific focus on social innovation is crucial as it can provide social engagement models to empower and engage residents, foster the co-design, co-development and co-implementation, offer spatial organisation allowing socio-economic activities and services, improve the wellbeing of citizens, and promote intergenerational and mixed forms of housing and accessible architecture open for cultural and creative innovation. Social innovation may also form a key aspect in developing business models for these types of lighthouse districts;
- Develop new bottom-up human-centred business models in housing area that facilitate engagement of residents in renovation – for example by co-investing, setting up energy communities, housing cooperatives and resident owned social services and (creative, green, ...) commons;
- Identify "ready to go projects" for the *lighthouse districts* as well as “low hanging”³⁸ fruit in terms of social housing renovation and worst performing buildings to test new methods, practices and technologies. The selected districts/ use cases, the diverse climatic and biogeographic conditions and settlement types in urban, sub-urban and rural areas across the EU are to be well reflected;
- Support businesses/ the private sector to develop demonstration projects that go the extra mile (environmental - social – cultural ambition) and allow innovations and new technologies putting inclusion and social progress at the forefront;

³⁷ Refers to the 14 Industrial Ecosystems for Recovery

³⁸ Many housing blocks in Eastern Europe are at the stretch of their “expiration date” and in need of a deep renovation. They are often located in proximity of each other which makes a district approach more beneficial. Many of the flats are owned by their residents, usually with no financial resources to renovate themselves. Therefore inclusive financial programs should be developed.

- Pilot circular construction methods taking into account the different industrial perspectives and value chains relevant for the renovation of the districts;
- Apply and pilot innovative smart housing applications (at individual dwelling level) and general smart grid or district level energy, waste, water, storage,... systems using newest technology at scale as well as technology that improves the social housing service provision itself;
- Plan actions for overcoming relevant barriers for renovation at district level with a majority of social housing dwellings (e.g. regulatory limits, lack of trust amongst different stakeholders, lack of private investors and awareness of the integrated approach potential);
- Effectively disseminate major innovation outcomes established in districts to support the implementation of industrial-urban symbiosis, connection to the European Community of Practice (ECoP) and development of flexible learning resources;
- Act as a catalyst for relevant EU projects and policies and channel this intelligence towards local projects and stakeholders, e.g. active aging, smart communities, including smart cities and smart villages, energy communities, skills, etc;
- The final objective is to obtain a set of 100 lighthouse districts that each have followed a different approach, focussing on different innovative solutions addressing the local reality and needs and to have demonstrated replication potential towards other districts by providing blueprints for replication and adaptation and by setting up a network amongst social housing providers.

Relevant indicators and metrics, with baseline values, should be stated clearly in the proposal.

Scope: To support a wide implementation of these district renovations, industrial urban symbiosis needs to be fostered amongst most relevant partners engaged in construction and renovation of social housing facilities. The local and regional dimension is important since local energy and utility networks, adjacent industrial infrastructures and available by-products and services in such districts would have to be considered in a holistic and integrated approach. In the same way, logistics should be optimised wherever possible and should be an advantage from the sustainable and competitiveness perspective.

Technology based innovations should prove the potential for novel symbiotic renovation projects acting as demonstrators involving multiple industrial sectors (combining non-exhaustively energy, construction, renewables, circular, electronics and creative industries, social housing associations and public authorities) in pilot multi-stakeholder partnerships focussing on a district approach and social needs related to social housing. Projects are expected to address:

- The development of a broader integrated methodology towards renovation of social housing districts starting from a cross-sectoral approach (e.g. INNOSUP) and

engagement models of residents to develop the application of technologies that make social housing more energy efficient, accessible and liveable;

- Research how technologies for housing and renovation can be adapted in a way that serves the needs of residents in social housing at affordable cost as well as how development at scale (e.g. district level of multi-apartment building) might bring cost optimisation and improve the affordability;
- The adaptation of technology in way it addresses the basic and essential needs of residents rather than to showcase the most advanced application from a technical perspective (human centred, fit for purpose and tailor made);
- Research on how renovation of social housing districts can deliver a more balanced population in terms of income, age and socio-economic profile as well as to avoid formation of *ghetto*'s on the one hand and *gentrification* on the other hand;
- Aspects of environmental friendly traffic and internet connectivity to facilitate inclusion are to be considered;
- Energy poverty issues that must be avoided as a result of the renovation. Social innovation and financial planning must ensure that the cost of living will not increase significantly for tenants and residents;
- Integration of ICT and digital tools, including smart grids, smart living applications, advanced modelling for eco-design and modular construction, to design and establish novel symbiotic interactions, data sharing and preservation of data confidentiality, as a non-exhaustive list;
- Assessment methodologies and KPIs to measure the performance of symbiosis, including environmental, economic and social impacts. Life cycle assessment and life cycle cost analysis should take into account existing sustainability standards (e.g. ISO 14000) and existing best practices;
- New skills acquisition in construction sector by piloting new technologies and processes in the renovation at district level focussing on needs in social housing;
- Development of common reporting methodologies for the assessment of industrial symbiosis activities and exchanges;
- Tools to support companies in redefining their products process and systems from the point of view of design, production, logistic and business models;
- Research on how realised lighthouse models can be duplicated and adapted to other social housing contexts, for example, where no strong social housing sectors are present or where participation models are less developed, such as energy communities and cooperatives;

- Lighthouse districts could display the application of European Bauhaus practices focussing on the aesthetic and co-creative aspects of renovation and building of social housing districts.

Clustering and cooperation with other selected projects under this cross-cutting call and other relevant projects as well as building on existing projects is essential, as many existing EU projects can contribute to very specific applications or process in such a district renovation.

Call - A DIGITISED, RESOURCE-EFFICIENT AND RESILIENT INDUSTRY 2021 (PCP)

HORIZON-CL4-2021-RESILIENCE-02-PCP

Conditions for the Call

Indicative budget(s)³⁹

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁴⁰	Number of projects expected to be funded
HORIZON-CL4-2021-RESILIENCE-02-01-PCP	PCP	Around N/A		
Overall indicative budget				

General conditions relating to this call

<i>Documents</i>	The documents are described in General Annex E.
<i>Admissibility conditions</i>	The conditions are described in General Annex A.
<i>Eligibility conditions</i>	The conditions are described in General

³⁹ 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 2021 and 2022.

⁴⁰ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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

Improving the resilience and preparedness of EU businesses, especially SMEs and Startups

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-02-01-PCP: Boosting economic recovery and strategic autonomy in Strategic Digital Technologies through pre-commercial procurement (PCP action)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Pre-commercial Procurement
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>The specific conditions for actions with PCP/PPI procurements in section H of the General Annexes apply to grants funded under this topic.</p>
<i>Legal and financial set-up of the Grant Agreements</i>	<p>The rules are described in General Annex G. The following exceptions apply:</p> <p>PCP/PPI procurement costs are eligible.</p> <p>The specific conditions are described in General Annex H.</p>

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

- Bring to the market new green, digital solutions that can increase Europe's resilience and preparedness to tackle the circular economy and climate challenge, whilst strengthening EU strategic autonomy in digital technologies;
- Advancing public sector modernization by capitalising on the transformational power of digital technologies to bring radical improvements to the quality and efficiency of public services;
- Leveraging PCP to drive innovation and increase resilience in the supply chain by opening up opportunities for innovative digitised companies, in particular SMEs and Startups, to access the public procurement market and scale up their business;
- Increased opportunities for wide market uptake and economies of scale for the supply side through increased demand for innovative green solutions, wide publication of results and where relevant contribution to standardisation, regulation or certification.

Scope: By closing the gap between supply and demand in a way that reinforces EU strategic autonomy, PCPs can make a key contribution to economic recovery and growth⁴¹. As the future is one of green digital growth⁴², European public procurers need to lead by example by procuring more green and more digital. This topic therefore focuses on forward looking procurement of R&D to bring to the market new green, digital solutions that can increase Europe's resilience and preparedness to tackle the circular economy and climate challenge.

This topic addresses Europe's Achilles heel on the road towards a green and digital economic recovery, the lack and fragmentation of public demand for innovative solutions⁴³. While it is well known that public sector modernisation and economic growth depend heavily on the use of ICTs, European investments on innovation procurement in ICTs are still lagging behind with a factor 3 compared to other leading global economies. Underinvestment is the biggest in particular for R&D procurement (factor 5)⁴⁴. Europe's startups and SMEs are indispensable in delivering the required innovations. As past experience shows that pre-commercial procurement opens up the procurement market for startups and enables the public sector to address societal challenges more effectively, Europe's Startup community⁴⁵ as well as public

⁴¹ [Impacts of EU funded PCPs](#) show 20%-30% efficiency and quality improvements in public services, doubling of the amount of public procurement directly awarded to startups/SMEs, a factor 20 increase in the amount of cross-border contract award to startups/SMEs and a factor 4 additional financing secured by startups/SMEs. The use of place of performance and IPR/commercialization conditions that fuel commercialization in Europe in PCPs also contributes to EU strategic autonomy.

⁴² [PCP showcases](#): see e.g. impacts of PCPs that commercialised greener solutions

⁴³ 'public authorities need to lead by example...', Green deal communication, December 2019

⁴⁴ 'A key factor in engineering economic turnaround will be the adoption of innovations... Europe's focus should be primarily on ICT-using sectors because ICT-producing sectors alone are unlikely to provide significant productivity increases to the economy... The EU and governments can do this through their own procurement.', [Report for EU Parliament](#), Oct 2018

⁴⁵ [SMART 2016/0040](#) that benchmarked European investments and policy frameworks for innovation procurement (study results to be presented and published in September-October 2020)

⁴⁶ [Startup Europe Summit recommendations](#), March 2019

procurers⁴⁶ have requested the Commission and Member States to increase investments in PCP.

This topic supports public buyers to collectively implement PCPs to drive innovation from the demand side and open up wider commercialisation opportunities for companies in Europe to take international leadership in new markets for strategic digital technologies that can deliver greener solutions. The aim is to leverage PCP to encourage the development and to provide a first customer reference for the piloting, installation and validation of breakthrough innovations.

Addressing public sector transformation typically requires combinations of different cross-cutting technologies and cooperation across public sector actors. The topic is thus open to proposals from all domains of public sector activity to address public sector challenges that require innovative ICT based solutions. It is open both to proposals requiring improvements mainly based on one specific ICT technology, and those requiring end-to-end solutions that need cross-cutting combinations of different ICT technologies. The work will complement PCP Actions foreseen under other topics.

Proposals should demonstrate sustainability of the action beyond the life of the project. The proposal shall demonstrate how the project is anchored in a clear strategy to fuel economic recovery in a sustainable way through stronger early adoption of innovative green solutions. Activities covered shall include cooperation with policy makers to reinforce the national policy frameworks and mobilise substantial additional national budgets for PCP and innovation procurement in general beyond the scope of the project.

Call - A DIGITISED, RESOURCE-EFFICIENT AND RESILIENT INDUSTRY 2022

HORIZON-CL4-2022-RESILIENCE-01

Conditions for the Call

Indicative budget(s)⁴⁷

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project	Number of projects
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⁴⁶ Results of a survey carried out by the EU among procurers that participated in past EU funded PCP and PPI actions (see [slide 28](#) for results of survey). Another specific survey, among procurers that participated in POV and PCP actions in the security domain, lead to the same conclusion that procurers want to more regular, annual open PCP calls.

⁴⁷ 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 2021 and 2022.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

			(EUR million) ⁴⁸	expected to be funded
HORIZON-CL4-2022-RESILIENCE-01-01	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-02	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-03	CSA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-04	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-05	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-06	IA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-07	IA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-08	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-10	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-11	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-12	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-13	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-14	IA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-16	IA	Around		

⁴⁸ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

		N/A		
HORIZON-CL4-2022-RESILIENCE-01-19	RIA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-20	IA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-21	CSA	Around N/A		
HORIZON-CL4-2022-RESILIENCE-01-22	CSA	Around N/A		
Overall indicative budget				

General conditions relating to this call

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

Novel paradigms to establish resilient and circular value chains

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-01: Circular and low emission value chains through digitalisation (RIA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Demonstrate an increase in the waste reduction by application of digital technologies
- Demonstrate optimisation of use of secondary raw materials in the value chains.

Scope: Circularity is an essential part of a wider transformation of industry towards climate neutrality and long-term competitiveness. It can deliver substantial material savings throughout value chains and production processes, generate extra value and unlock economic opportunities. While circularity is in simple terms addressed by waste from one process becoming secondary materials for others, an efficient use in the value chain in order to close the loop or reuse in other industries, can be ensured only through a transparent information system. There is thus a need for designing and piloting an information system for raw materials and components in products throughout the whole value chain of process industries.

Proposals should:

- Propose new solutions for improved use of secondary raw materials along the value chain of the own industry or in other industries;
- Propose methodologies for digital tracing and certification of secondary raw materials. This should include real-time access to information on material compositions and material quality along the whole value chain;
- Propose digital tools for integration of product passport and/or certification schemes;
- Propose open source software, open hardware design, and easy access to data, in order to facilitate access to information for the own and for other industries;
- Develop means and tools to indicate the composition and origin of recycled materials (bar code could be an option) indicating the composition and origin.

Finally, the projects should whenever possible contribute to standardisation.

This topic implements the co-programmed European partnership Processes4Planet.

Raw materials for EU strategic autonomy and successful transition to a climate-neutral and circular economy

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-02: Monitoring and supervising system for exploration and future exploitation activities in the deep sea (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Projects cost-effective outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Develop technologies and systems to continuously monitor environmental impacts and mitigation methods of deep sea exploration and future mining;
- Develop multi-scale systems to identify gaps on the relevant available environmental data needed to develop statistically robust baselines that take into account the tridimensional and temporal natural variability of the marine environment;
- Provide technological and systemic solutions for forecasting potential environmental impacts of using the developed monitoring and mitigation methods.

Scope: The global economic interest in deep-sea mineral resources has been growing and so are the concerns with the negative impacts on the deep sea ecosystems if mining activities start. The expected increase of the global demand for metals needed for the energy transition might become a driver to initiate commercial deep sea mining, paved by the technological advancements. However, before any deep-sea mining activities start, the environmental impacts, and how to mitigate them, need to be well understood; a robust legal framework needs to be in place and a reliable and transparent monitoring and supervising system for the activities taking place in the deep-sea has to be ready. For the sake of transparency and to properly assess the environmental consequences of the activities taking place in the deep sea over time, it is crucial to develop and to put in place a system capable of continuous monitoring, of the exploration and exploration activities, so the permitting and supervising authorities can access it remotely and at any moment.

The actions should design and develop a reliable and robust monitoring and inspection system for the exploration and future exploitation activities in the deep-sea. Before the monitoring and inspection systems are used a forecasting of the impact on the environment of these activities should be performed. Therefore, projects should deliver appropriate technological and systemic solutions for such forecasting assessments.

A monitoring and inspection system for the activities taking place in the deep sea is very complex because the activities take place in remote areas, in the middle of the ocean, and in an extreme environment, deep water column and consequent pressure and fragile ecosystems. The system needs to be fully transparent and capable of monitoring all relevant environmental parameters and at the same time protect business confidentiality. Due to the complexity of such system, the project has to be developed by a multidisciplinary team, looking at environmental, legal and technological solutions. Any bathymetry, geology, seabed habitats, chemistry, biology and physics marine data collected, in particular at the testing phase, should be INSPIRE compliant and made available through the European Marine Observation and Data Network (EMODnet).

The project will

1. identify all the bio-chemical-physical parameters to be monitored at the bottom of the sea, along the water column and at the surface;

2. identify all technical requirements needed for a real time monitoring of all parameters at the bottom, along the water column and surface, including the use of satellite data (Global Navigation Satellite System and Copernicus' satellite constellation) and to make it continuously available for remote access;
3. identify existing technological solutions and develop new ones to fulfil the technical requirements;
4. design and develop the architecture of the system in view of incorporating the monitoring parameters, the technical requirements and the legal constraints;
5. Develop a trial version of the system and test it.

The project should build on and explore synergies with previous and ongoing EU funded projects on environmental impacts and environmentally friendly technologies for exploration and exploitation of the deep sea. The project should cooperate closely with the International Seabed Authority, notably with its Legal and Technical Commission, and take into account the legal framework for the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction. The project should take into account the developments of the international legally binding instrument under the United Nations Convention on the Law of Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

HORIZON-CL4-2022-RESILIENCE-01-03: Streamlining cross-sectoral policy framework throughout the extractive life-cycle in environmentally protected areas (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to</p>

	<p>reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
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Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Exchange of good practices in permitting procedures related to extractive activities that may have an impact in environmentally protected areas;
- Dissemination and exploitation of projects outputs is tailored for competent EU, national and regional authorities, industry and civil society in EU Member.

Scope: Reconciling the increasing demand for Critical Raw Materials necessary for the EU climate neutral ambition, with nature protection, restoration and biodiversity growth, requires strengthening the raw materials policy framework. Streamlining more efficient, effective and transparent permitting procedures throughout the mineral extraction life-cycle in environmentally protected areas, would contribute to securing the sustainable access to primary raw materials, whilst taking into account and reconciling requirements in environmentally protected areas.

The actions should contribute to the exchange of good practices in permitting procedures related to extractive activities that may have an impact on environmentally protected areas. They should focus on reviewing good practices at the permitting stage in areas such as evaluating natural background conditions previous to the mineral extraction, evaluating the impact on human health and biodiversity, as well as foreseen nature protection and restoration measures.

The actions should analyse cross-sectorial policy coordination and integration covering economic, environmental and social aspects in the value chain of the extractive life cycle from finding and access to deposits to closure and rehabilitation, while focusing on the contribution of streamlined permitting procedures to deliver on the climate ambition of the European Green Deal.

The actions should develop and disseminate training materials, organize capacity-building workshops and seminars for competent authorities, industry and civil society in different Member States in different regions the EU and at the EU level.

All the data and information generated through these actions should be shared in open formats on a free of charge basis with the European Commission, for its own use and for publication.

HORIZON-CL4-2022-RESILIENCE-01-04: Developing digital platforms for the small scale extractive industry (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Develop digital platforms (applications) addressing needs of small-scale operations, mining clusters and SMEs, to enable a transformative change in EU extractive industries ensuring EU raw materials autonomy, while protecting and restoring biodiversity, boost our resilience, fight climate change and recover from the COVID-19 crisis;
- Contribute to the digitalisation of the extractive industry.

Scope: Actions should develop digital platforms that integrate Earth Observation data, in situ data and data modelling, to improve data management and decision making during the extractive process. Proposals are encouraged to make use of, but not limited to, existing EU and Member States data infrastructures.

These digital platforms should scale up to the increased data volumes of the extractive activities, incorporating assimilation techniques and interoperability best practices, automation, systemization and integrated web-based services, and be brought into pre-operational service provision, going beyond the demonstration phase.

Actions should contribute to digitalize the extractive industries operations and, being INSPIRE compliant, help data gathering at EU level for evaluating the performance and competitiveness of extractive industries.

These digital platforms should contribute to increase the dialogue between the extractive industry and EU citizens, raising awareness about the impact of raw materials on the value chains and society well-being and reinforcing the commitment of the industry to protect human health and natural eco-systems.

Building on past projects, the actions should provide practical and easily applicable capacity building and training materials for a better environmental management of active operations. They should also include exchange of best practices and capacity building for the effective monitoring of extraction sites by competent authorities.

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

Actions should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could

help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

HORIZON-CL4-2022-RESILIENCE-01-05: Technological solutions for tracking raw material flows in complex supply chains (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Improve supply chain data transparency and traceability;
- Setting up technological solutions for tracking raw material flows (material passports);
- Identify and address gaps in due diligence;
- Develop comparable criteria, reporting and audit approaches;
- Contribute to sustainable sourcing of raw materials;
- Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 4 - Map the potential supply of secondary critical raw materials from EU stocks and wastes and identify viable recovery projects.⁴⁹

Scope: There is a need to improve supply chain data transparency and traceability, enabling consumers and downstream producers to have information about the origins of metals in finished products. Due diligence has numerous research gaps in this area which need to be addressed in order to limit complexity and enable a level playing field for responsible sourcing of minerals.

This action should close those gaps by the setting up of technological solutions for tracking raw material flows (material passports), building upon comparable criteria, reporting and audit approaches. Examples would include transparency in payments and traceability from beginning to end of the supply chain, through a chain of custody certification, and the use of block chain technology in an effort to improve supply chain transparency and traceability.

The action should build on the experience of existing EU projects on international responsible sourcing and contribute to strengthening responsible sourcing agenda.

It is foreseen that this will facilitate responsible sourcing in complex supply chains and put companies downstream in the supply chain in a better position to influence companies upstream.

The proposal should build on the state of the art in sustainable raw materials traceability with regard to sustainability certification schemes, standards and initiatives as well as block chain technology. The proposal should also build on the experience from earlier Horizon 2020 projects in the area of responsible sourcing of raw materials in global value chains. The proposal should cover CRMs in at least 2 complex supply chains, including a batteries value chain.

The action should contribute to building the EU knowledge base of primary and secondary raw materials by feeding into the European Commission's Raw Materials Information System – RMIS. The action should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society and of the challenges related to their sustainable supply.

⁴⁹ COM (2020) 474

HORIZON-CL4-2022-RESILIENCE-01-06: Sustainable and innovative mine of the future (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Develop sustainable and smart mining technologies for exploitation of EU mineral resources;

- Contribute to a more safe and environmentally friendly, resource- and production efficient sustainable mining;
- Develop methods, technologies and processes aiming for digitisation and automation of raw materials production;
- Target minerals and metals;
- Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 8: Develop Horizon Europe R&I projects on processes for exploitation and processing of critical raw materials to reduce environmental impacts starting in 2021 and Action 3: Launch critical raw materials R&I in 2021 on waste processing, advanced materials and substitution.⁵⁰

Scope: Actions should contribute to developing big data technologies and Artificial Intelligence methodologies addressing mining industry requirements to deliver on the climate ambition of the European Green Deal. The challenge is to accelerate the innovation in the mining sector necessary for the digital transformation. They shall aim to develop new, enabling, operational solutions to improve capabilities and performance of the raw materials value chain: from in situ mineral exploration and permitting procedures, to mineral extraction and processing including recycling, as well as closure and post closure activities.

Actions should push the EU to the forefront of a safer, more sustainable and intelligent extraction of mineral resources through the deployment of technologies such as electrification of ground and underground mobility, remote controlling, automation or autonomous processes with a particular focus on historic mine sites and deep deposits. Actions should develop sustainable solutions through industrial and user-driven multidisciplinary consortia covering the relevant mining and processing value chains and technologies.

Proposals can address individual elements of the raw materials value chain or the value chain as a whole, and should provide quantitative measures of the progress beyond the state of the art. Proposals are also required to seek end user involvement to drive the research with their requirements and test the developed solutions, with a clear path to the exploitation of the results.

The action should facilitate the market uptake of solutions developed through industrially- and user-driven multidisciplinary consortia covering the relevant value chain and should consider standardisation aspects when relevant.

The action should justify the relevance of selected pilot demonstrations in different locations within the EU (and also outside if there is a clear added value for the EU economy, industry and society). The action should include an outline of the initial exploitation and business plans

⁵⁰ COM (2020) 474

(with indicated CAPEX, OPEX, IRR and NPV⁵¹) with clarified management of intellectual property rights, and commitment to the first exploitation.

The action should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

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

HORIZON-CL4-2022-RESILIENCE-01-07: Innovative solutions for efficient use and enhanced recovery of mineral and metal by-products from processing of raw materials (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope</p>

⁵¹ Capital expenditures (CAPEX), operational expenditure (OPEX), internal rate of return (IRR), and net present value (NPV)

	<p>specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	Activities are expected to achieve TRL 6-8 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials and secondary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Increase process selectivity, broader range and higher recovery rates of valuable raw materials, particularly critical raw materials;
- Unlocking substantial reserves of new or currently unexploited/underexploited resources within the EU;
- Significantly increase economic performance in terms of higher material-, water-, energy- and cost-efficiency and flexibility in minerals processing, metallurgical or recycling processes;
- Significantly improve the health, safety and environmental performance of the operations throughout the whole life cycle which is considered, including a reduction in waste, wastewater and emissions generation and a better recovery of resources from generated waste;
- Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 8: Develop Horizon Europe R&I projects on processes for exploitation and processing of critical raw materials to reduce environmental impacts starting in 2021 and Action 3: Launch critical raw materials R&I in 2021 on waste processing, advanced materials and substitution.⁵²

Scope: Actions should develop sustainable systemic solutions through industrially- and user driven multidisciplinary consortia covering the relevant value chain of non-fuel, non-food raw materials.

Actions should develop energy-, material- and cost-efficient new sustainable mineral processing and/or metallurgical technologies and processes to increase the selectivity and the

⁵² COM (2020) 474

recovery rates of valuable by-products⁵³, particularly critical raw materials⁵⁴. The importance of the targeted raw material by-products for the EU economy should be duly demonstrated in the proposal. Recycling of end-of-life products is excluded from this topic.

The action should facilitate the market uptake of solutions developed through industrially- and user-driven multidisciplinary consortia covering the relevant value chain and should consider standardisation aspects when relevant.

The action should justify the relevance of selected pilot demonstrations in different locations within the EU (and also outside if there is a clear added value for the EU economy, industry and society). The action should include an outline of the initial exploitation and business plans (with indicated CAPEX, OPEX, IRR and NPV⁵⁵) with clarified management of intellectual property rights, and commitment to the first exploitation.

Actions should also contribute to improving the awareness of relevant external stakeholders and the general public across the EU about the importance of raw materials for society, the challenges related to their supply within the EU and about proposed solutions which could help to improve society's acceptance of and trust in sustainable raw materials production in the EU.

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

HORIZON-CL4-2022-RESILIENCE-01-08: Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

⁵³ The term "by-products" should be interpreted here as the constituents usually accompanying the major component(s) of a raw material at low concentrations.

⁵⁴ EU list of critical raw materials 2020 – add link when published

⁵⁵ Capital expenditures (CAPEX), operational expenditure (OPEX), internal rate of return (IRR), and net present value (NPV)

<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to increase EU resilience in raw materials supply chains for EU industrial value chains and strategic sectors to enable their green and digital transition and to reduce current EU over-dependence on a few third countries for critical raw materials by diversifying supply and using environmentally friendly technologies, participation to the call is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and Latin America.</p> <p>Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p><i>[TO BE DECIDED: We would like to apply Art. 18.5.2 subject to a condition relating to some kind of pre-screening; to be confirmed if this is possible and allowed, and if yes, how this must be legally formulated.]</i></p>
<i>Technology or Societal Readiness Level</i>	<p>Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.</p>

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by increasing access to primary raw materials, in particular critical raw materials for EU industrial value chains and strategic sectors.

Projects are expected to contribute to the following outcomes:

- Unlock the potential of Earth Observation technologies, including Copernicus, through the development of downstream products and services for the whole mining life cycle,
- Strengthening EU autonomy in the area of raw materials, while enabling a successful transition to a climate-neutral, circular and digital EU economy;
- Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 7 - Deploy Earth-observation programmes and remote sensing for resource exploration, operations and post-closure environmental management.⁵⁶

Scope: Actions should develop and innovate new methods to analyse Earth Observation data, enabling systematic mineral exploration and continuous monitoring of extraction, closure and post closure activities.

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These developments and innovations should be built upon Copernicus satellite constellations, airborne and low-altitude platforms, ground based remote sensing, also including conventional in situ techniques, methods and field work measurements.

Actions targeting mineral exploration should develop EO methods that exploit multispectral, hyperspectral and in situ data permitting to systematically revise and update pre-existing maps and datasets identifying new mineral deposits at various scales, from mining regions to specific mining projects.

Actions targeting monitoring of extraction, closure and post closure activities should develop EO methods that exploit radar, optical and in situ data to innovate products and services: a) early warning systems and platforms that reduce operation risks; b) multi-sensor and multi-platform environmental monitoring systems that reduce the impacts on human health and preserve ecosystems.

Foreseen outputs of this action could be, but not limited to, new methods to exploit EO data permitting to generate the following results at various scales, from mining regions to specific mining projects.

For mineral exploration:

- improved maps of critical raw materials
- improved maps of mining waste deposits
- improved seabed mineral mapping by exploring the connection between sea shore and coastal areas

For mining monitoring:

- Ground instability maps
- Mineral stockpile volume estimation
- Acid mine drainage maps

Green and Sustainable Materials

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-10: Innovative materials for advanced nanoelectronic components and systems (RIA)

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

	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

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

- Develop innovative new components and systems with improved functionality and performance enabling added value to the European industry in sectors such as healthcare, automotive, energy, smart cities, smart textiles and manufacturing;
- Impacts are also envisaged to smart grids, efficient through life performance monitoring, smart manufacturing, digital industry with increased computing performance and efficient data storage.

Scope: Europe aims to become a global role model for the digital economy and society. Electronic components and systems (ECS) are the building blocks for this. Electronic components and systems are core enablers and differentiators for the development of many innovative products and services in all sectors of the economy. In 2018 electronic system production exceeded 2 000 B€ for the first time in which 15% occurs in Europe.

Research and innovation are key to maintain the competitiveness of the European ECS industry, generating growth, creating value, jobs and prosperity. Materials innovation lies at the heart of this endeavour.

Actions under this topic must address one or more of the following technologies:

- Innovative materials design and processing for devices based on new and emerging technologies, such as spintronics, neuromorphic, in-materio computing multisensing, photonics, nano-mechanics advanced ferroelectrics or biosensing;
- Heterogeneous integration of new materials (such as PZT, graphene, titanium oxide or aluminum oxide) for miniaturised sensor and actuator modules.

Proposal should indicate the key quantitative specifications to be achieved and develop demonstrator components/systems to showcase the desired functionalities. Proposals are also expected to prove the industrial relevance of the intended approach, establishing links to applications likely to benefit from the development.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2022-RESILIENCE-01-11: Advanced lightweight materials for energy efficient structures (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: The positive environmental impact of lightweight composite materials most often occur due to benefits during the use-phase. The overall life-cycle benefits are often reduced as a consequence of negative environmental impacts associated with the manufacturing (energy consumption) and inherent challenges to regain the high-value components (fibre and matrix) at industrial scale. Development of new chemistries for fast curing resins, new bio-based composites (including fibres and core materials) and associated novel production techniques are expected to result in

- Reduced cost for production of renewable lightweight materials, 25 % lower cost than currently used materials;
- Light-weight products containing >50% sustainable, bio-based materials;
- Up to 30% lightweight potential through tailored functionality for a range of extreme environment (infrastructures, aeronautics, space) applications and in surface transport;
- Reduction in CO₂ emissions (LCA) of at least 20 %;
- Business models and circular value chains for lightweight bio based components;
- Improved time-to-market for European providers of lightweight solutions.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: A step change is needed to develop new sustainable and high performance lightweight materials and associated novel manufacturing techniques. Research areas to be addressed include:

- Development of new chemistries for fast curing resins (including bioresins) and associated novel production techniques (e.g. out-of-autoclave processes to reduce energy consumption);
- Utilisation of existing or development of cost competitive renewable resins and/or core materials in combination with new fibres to make all renewable lightweight composites and structures;
- Technologies and material design paradigms that enable hybrid composites based on a variety of constituents e.g. combinations of virgin and recycled fibres, bio-fibres including appropriate fibre coatings, etc. towards maximum cost and environmental benefits with a life-cycle perspective;
- High performance high temperature polymer composites with potential to extended use at temperatures above 300C. Besides general material and manufacturing, the long-term durability of materials in service is a potential area of research and development;
- New multifunctional composites where the materials and structures, besides traditional structural capacity, also is optimized towards one or several other functions such as thermal management (heating/cooling), energy harvesting and storage, morphing etc.;
- New recycling technologies for polymer composites structures and, in particular, composite constituents. The high value constituents e.g. carbon fibres or matrix are not easily separated and technologies to recycle both in the same process should be addressed.

Improving advanced lightweight materials will have a positive environmental impact, which is in direct relation to the well-being of citizens.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.
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Expected Outcome: Optimised lightweight designs often require the use of multi-materials, often with different physical properties, such as polymers composites and metals. The manufacturing of multimaterial structures is thus a challenging task and many industries are today addressing specific critical challenges that come with mixing of materials. It is of great importance that multimaterial design is analysed from a holistic and multidisciplinary perspective where all aspects from design to manufacturing, use and recycling are included in the process. This will help industry make the change from traditional design based on one material to multi-material design of lightweight structures.

Projects are expected to contribute to the following outcomes:

- Contribute to energy efficiency, increase competitiveness of new multi-materials items and multi-functional materials and products for a wide range of applications in the additive manufacturing industries and in specific industrial sectors e.g. transport including aeronautic, and maritime, consumer customised goods, communications, biomaterials, health and energy;
- Develop optimised structures in terms of operational performance and weight with a goal of reducing weight by 50% compared to traditional designs;
- Reduced lead-time of multimaterial products of 20% compared to today's design of multimaterial products that creates an increased competitiveness for the EU's industry;
- Strengthening of the EU's manufacturing industry through the intensive implementation of innovative and unconventional technologies along the EU's manufacturing value chain;
- Combine materials with high uniformity and with high mobility in industrial quantities with high reproducible quality;
- Increase of the product performance by at least 30% whilst retaining the product price;
- Dissemination of the challenges and benefits of functional multi-material components and structures in the relevant industrial sectors.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: By combining several materials, proposals should advance the state of the art through the development of ready assembled multifunctional devices. The role of new development in additive manufacturing processes with dissimilar materials will be of importance. Proposals should address and demonstrate several of the below simultaneous activities:

- Quantification of improved functionalities, properties, quality and lifespan of fabricated pieces;
- Evaluation of matching materials properties to the production process to enable the joining of dissimilar materials for AM tools;
- Combination of precision engineering design with additive manufacturing methods to provide tailor-made joining solutions for dissimilar materials, with the ability to be reused/dismantled;
- Demonstration of a better understanding of the nanotechnology integrated materials properties and manufactures;
- Integration and validation at early stage of the qualification and certification considerations of the materials, including innovative non-destructive inspection techniques;
- Joint development with material suppliers and end-users is required for a rapid uptake by industry;
- Modelling, standardisation and regulatory aspects (especially safety and nano-safety) and the process and materials qualification.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

Materials for the benefit of society and the environment and materials for decarbonising Industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-13: Smart and multifunctional biomaterials for health innovations (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end

<i>Societal Readiness Level</i>	of the project – see General Annex B.
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Expected Outcome: Multi-functional biomaterials are capable, by virtue of their own material ingredients or surface properties, of achieving several biological responses simultaneously. They may also help to dampen those that are undesirable such as inflammation, infection, corrosion and issues related to bio and immune compatibility, while taking into account the specificities due to sex, race and age.

Projects are expected to contribute to the following outcomes:

- Offer solutions through the development of multifunctional biomaterials to address and mitigate multiple bottlenecks in response to unmet clinical needs;
- Provide improved biocompatibility, biospecificity and longevity of medical devices;
- Show that the regulatory and IPR strategies are compatible with the overall research objectives.

Scope: Multifunctional biomaterials play a major part in shaping the future of Advanced Therapies and Medical Devices. Health applications may include but are not limited to tissue engineering, artificial organs, implants, microfluidics, bioactive scaffolds, wearable and implantable devices, in-vitro diagnostics etc.

Projects funded under this topic should further:

- Develop and/or validate specific multifunctional biomaterials for use in an eventual advanced therapy, medicinal product or medical device;
- Preclinical regulatory affairs as well as manufacturing processes would also need to be addressed, including up-scaling and good manufacturing practice (GMP);
- Pay special attention to the needs of Small and Medium-Sized Enterprises (SMEs) as well as to the ultimate clinical applications of these biomaterials;
- Present a solid economical evaluation of possible savings, together with patient benefits.

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2022-RESILIENCE-01-14: Membranes for gas separations - membrane distillation (IA)

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

<i>project</i>	proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Advanced membrane materials are essential to achieve the goals of the European Green Deal with significant reductions of industrial emissions in waste streams like wastewater and waste gas like removal of gas / volatile pollutants from liquid emissions or purification of wastewater.

Projects are expected to contribute to the following outcomes:

- The next generation membrane materials, delivering smart solutions for greening of industrial plants;
- Advanced membrane materials for recycling of waste streams from industrial plants to support the Zero Pollution strategy;
- Better materials with outstanding separation performance and/or superior properties either in chemical, mechanical or thermal stability compared to commercial materials;
- Reduction of the water footprint of 10% in industrial plants for the preservation of freshwater resources;
- Up-scaling the desalination process by solar powered membrane distillation systems and coupling membrane distillation with solar / photovoltaic collectors;
- Energy saving by 10% through the application of a new generation of membranes.

Scope: Membranes separation is one of the key process elements needed for the next level of resource efficiency and for greener industrial plants. Proposals will address the development of the new generation membrane materials from gas separation to membrane contactors in comparison to the current state-of-the-art. Guidance by modeling and simulation techniques should be provided to save on extensive experimentation and support up-scaling.

Proposals should address at least two of the following activities:

- Advanced membrane materials for the recovery of valuable components (ammonia, phosphate, alcohols, reactants, products, catalysts) from aqueous, organic and mixed aqueous/organic process and waste streams to enhance the resource efficiency in industrial plants;

- Separating gas streams (e.g. CO₂ utilisation processes) in the process emissions by using membrane technologies, where in addition to the produced product, other gases are in the stream (e.g. unreacted CO₂ and hydrogen);
- Demonstrate the next generation of porous membranes for membrane contactors (membrane distillation, gas/liquid contactors, liquid/liquid contactors) with use of renewable energy sources (solar energy or waste heat) to achieve significant reduction in CAPEX and process costs of gas separations and distillation;
- Up-scaling the desalination process by solar powered membrane distillation systems by coupling membrane distillation with solar / photovoltaic collectors;
- New membrane materials to reduce the water footprint in industrial plants for the preservation of freshwater resources (e.g solvent tolerant reverse osmosis membranes, forward osmosis).

In line with the European Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

HORIZON-CL4-2022-RESILIENCE-01-16: Building and renovating by exploiting advanced materials for energy and resources efficient management (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

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

- Buildings are responsible for approximately 40% of energy consumption and 36% of CO₂ emissions in the EU. Renovation of existing old buildings has the potential to lead to significant energy savings – potentially reducing the EU's total energy consumption by 5-6% and lowering CO₂ emissions by about 5%;
- Compared to state of the art materials and components, the newly developed materials should deliver:

- o Reduction by at least 30% of the embodied energy and CO₂ at component level;
 - o Improvement by at least 20% of insulation properties;
 - o Reduction by at least 15% of the total costs compared to existing solutions;
 - o Demonstration of at least a 5% reduction of the energy spent during the whole life cycle of a building.
- Demonstrate innovative retrofitting solutions using the building insulation materials as real cases approaching net zero energy standards and their replicability potential;
 - Improvement of the quality of information from product manufacturers to facilitate better decision making;
 - Strengthening of the competitiveness of the European construction sector in the field of “green” construction technologies;
 - Sustainable building materials will be supporting the circular design. Self-sustaining buildings in respect to energy usage;
 - New insulation materials shall be cost effective, environmentally safe, fire resistant and can be easily applied on existing surfaces (e.g. spray coating);
 - Return on investment should be below 7 years for deep retrofitting of buildings;
 - Advent of a new generation of skilled workers and SME contractors in the construction sector aware of the need of a systemic approach towards energy efficiency should be promoted through the proposed activities.

Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

Scope: Building envelopes and renovation materials that boost energy savings, save resources and decrease carbon emissions, both during construction and operation of the buildings. In view of the climate targets, Europe's building infrastructure needs a deep rehabilitation of residential buildings (including buildings of historic value) while lowering the costs of refurbishment. Building materials with adequate insulation properties are directly related to the Green Deal and the well-being of our citizens.

Proposals should address and demonstrate several of the below activities:

- Demonstrating that new insulation materials (not external cladding) will have reduced embodied energy, lower CO₂ emissions and improved insulation properties during operation, and are cost effective, environmentally safe, fire resistant and can be easily applied on existing surfaces (e.g. spray coating);
- New components shall also contribute to improve indoor air quality, by limiting VOCs emissions and/or by advanced properties aiming to absorb and biodegrade indoor contaminants;

- Enhanced durability for increased use duration, reduced maintenance and consequently reduced costs, respect of sustainability principles (the sustainability of each developed solution should be evaluated via life cycle assessment studies carried out according to the International Reference Life Cycle Data System - ILCD Handbook);
- New components shall have to be lightweight construction with an ease of installation and provide for increased comfort and noise reduction, and find application to both new build and renovation and deliver realistic solutions at a reasonable price;
- Energy efficiency shall be addressed by system integration and installation, exploiting synergies between technologies, which proved valid at a small scale and need a larger scale demonstration;
- Synergy with existing relevant Open Innovation Test Beds is encouraged;
- Clustering and cooperation with other relevant projects is strongly encouraged; in particular, liaison and synergies with the Horizon Europe Partnership on 'People-centric sustainable built environment' and Build4People.

Building materials with adequate insulation properties are directly related to the Green Deal and the well-being of our citizens.

The topic is open for international cooperation where the EU has reciprocal benefit, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed.

Materials and data cross-cutting actions

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-19: Advanced materials modelling and characterization (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Technology or Societal Readiness</i>	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

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Expected Outcome: The future of European industrial manufacturing requires further advances in characterisation methods and computational modelling, in order to lead the way to the reliable design of new and sustainable materials and processes, rapid upscaling, and effective quality control. These advances can only be achieved through the development of innovative techniques and a new generation of instrumentation, responding to industrial needs.

Projects are expected to contribute to the following outcomes:

- Develop an open repository for knowledge transfer, data sharing for integration between advanced materials characterisation (material properties/functionalities) and modelling (data and physics based, engineering modelling), allowing full interoperability between data and workflows (CHADA, MODA and EMMO), with direct connection to manufacturing process;
- Enable a model-based innovation processes covering all stages from materials design to product development and life cycle assessment, with the aim, in particular, of translating industry needs into scientific problems and provide solutions;
- Increase the efficiency and effectiveness of materials and product development by reducing costs and time for product design, time-to-market and regulatory compliance, which will enable the transition to a decarbonised economy;
- Improve handling of missing data by means of artificial intelligence/machine learning methods;
- Proposals should include a business case and exploitation strategy after the end of the action.

Scope: Proposals should:

- Develop a relevant range of characterisation methods and models to enhance the design – with clear demonstration of modelling and characterisation integration - and development stages of advanced materials and products, focusing on user cases related to low carbon and clean industry applications;
- Coordinate efforts towards data documentation, exchange procedures and ontologies that can aid the traceability, integrity and interoperability of data in line with Industry Commons and FAIR data principles;
- Seek the involvement of standardisation bodies for the development of standards, test guidance or guidance documents;
- Focus on the combination of theory with large-scale computational screening (e.g. Artificial Intelligence or Machine Learning);

- Facilitate the re-use of existing research results on modelling and characterisation, as well as the uptake of new project results.

HORIZON-CL4-2022-RESILIENCE-01-20: Climate Neutral and Circular Innovative Materials Technologies Open Innovation Test Beds (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Technology or Societal Readiness Level</i>	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Climate Neutral and Circular Innovative Materials Technologies are essential in enabling the transition towards a European decarbonised economy. They can contribute to a stronger circular economy, a cleaner Industry, a more sustainable growth and reduction of greenhouse gas emissions, which is fully in line with the Green Deal Strategy. To maintain its competitive advantage in clean Materials technologies the EU needs to increase significantly the large-scale deployment and demonstration of new technologies across sectors and across the single market, building new innovative value chains. Climate Neutral and Circular Innovative Materials Technologies Open Innovation Test Beds (OITBs) will support companies, especially SMEs, to become world leaders in clean products and technologies.

Projects are expected to contribute to the following outcomes:

- Increase significantly the large-scale deployment and demonstration of Climate Neutral and Circular Innovative Materials Technologies across sectors and the single market, as well as to build and maintain new innovative value chains;
- Reduce the technological risk of innovative materials and products, thus attracting more investors, and cut the time to market;
- Support companies, especially SMEs, to become world leaders in clean products and technologies by setting up a new generation of Open Innovation test Beds focused on the creation of Business Opportunities and Sustainability. Enhancing ownership and engagement of the society through active collaboration and empowering people and communities as actors of the climate neutral and circular transition ;

- Translation of industrial needs into scientific problems and concrete solutions, increased awareness and uptake by industry, and effective access of relevant stakeholders to know-how and advanced tools/infrastructure.

Scope: The following specific activities should be considered:

- Establish Open Innovation Test Beds (OITB) by upgrading existing or developing new materials facilities and pilot lines, and made available services for the design, development, testing, regulatory and environmental assessment and upscaling to industry and interested parties, specially SMEs;
- Specific focus will be given to the sustainability of the ecosystem by designing new funding instruments that would complement the already existing ones and provide further support for industrial uptake of climate neutral and circular innovative materials technologies in key strategic value chains;.
- Proposals should include actions designed to facilitate cooperation with other projects, to enhance user involvement and to reuse other projects results;
- Open access at fair conditions and cost as well as outreach and dissemination across Europe, based on a distinct methodology;
- Demonstrate measurable reduction of costs for product design, time-to-market and regulatory compliance by means of faster and cheaper evaluation of production process deviations. Relevant indicators and metrics, with baseline values, should be clearly stated in the proposal.

In order to avoid duplication, the work will be aligned with the third pillar on Open Innovation that will essentially focus on scaling up breakthrough and market-creating innovation by establishing a European Innovation Council, support the enhancement of European ecosystems of innovation and continued support to the European Institute of Innovation and Technology (EIT) OITB for: Clean hydrogen Technologies; Fuel cells and other alternative fuels; Carbon capture, storage and utilisation.

Improving the resilience and preparedness of EU businesses, especially SMEs and Startups

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-21: Leveraging standardisation in Strategic Sustainability and Digital Technologies (CSA)

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

	different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome: Connecting European stakeholders ecosystems, including of SMEs, with European and International standardisation bodies and other relevant actors. Identification of Sustainability and ICT standardisation areas, which need European intervention and proposal of actions to address them.

Projects are expected to contribute to the following outcomes:

- Engagement of required stakeholders and experts to ensure lasting impact;
- Increase the influence of Europe into international Sustainability and ICT standardisation, ensuring promotion of European requirements, values and interests;
- Set-up of a facility to support participation of European specialists in international ICT SDOs, Sustainability and technical bodies;
- Increase the participation of European specialists in international Sustainability and ICT Standardisation activities to support European values and interests, including in leadership positions;
- Getting working items at the right time into the right technical bodies in international SDOs, fora and consortia;
- Synergies with other similar initiatives or European players including from EU (and national) funded R&I projects;
- Common positions of European stakeholders in international Sustainability and ICT standardisation;
- Increase awareness and education on Sustainability and ICT standardisation.

Scope: This action will involve and empower European stakeholders participating at the development of open technical specifications and standards with the aim to representing European values and ethics, strengthen the take-up, scalability cross-border and cross-sector interoperability of their technological solutions, as well as, decreasing the costs of technical due diligence to the public and private procurers.

The aim is to reinforce the presence of EU and associated states experts in the international Sustainability and ICT standardisation scene, by setting up a standardisation observatory and a facility supporting the participation of key European specialists (especially from SMEs and Academia) in key international and global Standard Developing Organisations.

Key tasks to be carried out are:

- Mapping of the relevant activities in international Sustainability and ICT standardisation, including identification of sectors where additional presence of EU experts may be needed. When relevant hosting standardisation meetings and workshops in Europe;
- Setting up of a management facility to support participation and leadership (e.g. chairing of technical committees) of key European specialists (incl. from SMEs and academia) in those organisations and technical bodies identified. The aim should be to achieve critical mass from industry, including SMEs and Startups, and academia for emerging standardisation activities;
- Liaise with relevant on-going developments in EU and national funded R&I projects, in particular with projects having identified standardisation output or with potential relevant results, including as well other coordination and support actions, and relevant PPPs;
- The consortium will define the process for an open call allowing the funding of the key European specialists to participate in international Sustainability and ICT standardisation activities to fulfil the scope of the call. The consortium will also define the process for an open call that will lead to a selection of an additional pool of specialist experts that may be needed to evaluate the applications for funding specialists to fulfil the scope of the proposal. In addition ad-hoc selection processes may be required. Financial support for these specialists will be typically in the order of EUR 1.000 – 10.000 per action by third party;
- Promotion of the relevance and benefits of Sustainability and ICT standardisation. The proposal will also include actions, including development of tools and materials, to promote education on ICT standardisation;
- The consortium will be developing strategies for a sustainable production and consumption of materials and products, industrial processes, and in particular aspects of circularity and the End-of-Life management;
- The proposal should take into account the previous activities carried out on Sustainability and the observatory and facilities for funding experts within the topic ICT-40-2017 implemented by the StandICT.eu project and under ICT-45-2020 implemented under StandICT.eu2023 project under (see <http://www.standict.eu>).

HORIZON-CL4-2022-RESILIENCE-01-22: SMEs' Green Innovation Associate (CSA)

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

	different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Support objectives of the European Green Deal and of the EU SME Strategy for a sustainable and digital Europe;
- Increased resilience and increased innovation capacity of SMEs by acquiring new expertise and skills to support their efforts to adopt new sustainable products, processes, services or business models;
- Turning creative business ideas into concrete innovations contributing to Green Deal goals.

Scope: This innovation capacity building action will provide a grant at European level to visionary⁵⁷ SMEs that can demonstrate that the skills required for a particular innovation idea supporting the goals of the Green Deal⁵⁸ – and in particular their efforts to adopt new sustainable products, processes, services or business models - are not within reach for them at national level (for example because the required skills are not available or not affordable for SMEs).

SMEs are supported to employ a highly skilled experienced researcher (referred to as an 'innovation associate') for a continuous period of one year. The innovation associate's task will be to explore, during the course of his/her contract, the potential of their innovative idea and turn it into an innovation project, supporting the SME's transition to sustainability.

This enterprise-led mobility programme builds upon the 'Innovation Associate' pilot launched under the Horizon 2020 Work Programme "Innovation in SMEs", and complements Marie Skłodowska Curie actions (MSCA) by focussing on SMEs needs.

The evaluation of proposals will focus on the demonstrated benefits of recruiting transnationally i.e. the impact for the SME to get access to skills not available on the national labour market; the excellence and impact of the innovative idea, its contribution to the Green

⁵⁷ Vision: 'A statement about what the organisation wants to achieve in terms of innovation. The vision should set a direction and a challenge that can inspire persons to commit and work towards, be sufficiently ambitious and not constrained by the organisation's current abilities, provide a target against which progress can be measured.' See Innovation management standard CEN/TS 16555-1 (July 2013)

⁵⁸ Defined for the purpose of this action as : Increasing the EU's climate mitigation and/or adaptation ambition; Supplying clean, affordable and secure energy; transitioning of industry to a clean and/or circular economy (including waste prevention and/or recycling); building and renovating in an energy and resource efficient way; accelerating the shift to sustainable and smart mobility; transition to a fair, healthy and environmentally-friendly food system; preserving and restoring ecosystems and biodiversity and realising a zero pollution ambition and a toxic-free environment

Deal goals as well as the coherence and effectiveness of the recruitment plan, which should offer the same opportunities for male/female candidates. Social innovation is recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

SMEs that will receive a grant will be obliged to advertise their vacancy on EURAXESS, unless a contract with an innovation associate has already been signed in line with the provisions above. They are also encouraged to publish the vacancy notice on any other relevant platform or media, with a clear indication that the grant was awarded.

The innovation associate's tasks are to identify the potential of the company's innovation idea with the objective and turn it into an innovation project and - hopefully - a continuation of the employment of the innovation associate. During the period covered by the grant, the Innovation Associate must work exclusively on the project described in the grant agreement.

In line with the orientation of the action and with the aim to accelerate the integration of the associate in the company's staff, the following costs are eligible for reimbursement under the grant:

- Personnel costs of the associate.
- Relocation costs of the associate, which may include removal cost, travel cost of the associate and his/her immediate family (if applicable) to the new place of employment, visa cost (if applicable), translation cost of certificates (if applicable), a temporary transition allowance to cover extra costs upon arrival in the place of employment, cost for the relocation in the country of origin after the project, as well as other clearly justified expenditure directly related to relocation.
- Travel and subsistence costs of the associate to the core training programme and travel and subsistence for tailored training (as described in the personal development plan). Travel cost and subsistence for the supervisor may be eligible for up to two training sessions.
- Travel and subsistence cost for the innovation associate and the supervisor in the enterprise to one kick-off meeting in Brussels (one day), organised by the European Commission⁵⁹.

Personnel cost may include allowances that are in line with the beneficiary's standard practices (for example child education or housing allowances).

Other costs like recruitment costs, equipment costs or travel costs to action-specific workshops by the supervisor in the enterprise are covered by the flat rate indirect cost.

⁵⁹ The organisation of such a meeting is subject to confirmation by the European Commission at a later stage.

Any cost not directly related to the employment and training of the innovation associate - for example cost of research, dissemination or promotion activities and other cost relating to the actual implementation of the innovation idea/project - are not eligible under this call.

This topic will take the form of lump sums as defined in Commission Decision C(2017)7151 of 27 October 2017. Details of the lump sum funding pilot scheme are published on the Funding & Tenders Portal together with the specific Model Grant Agreement for Lump Sums applicable.

The following criteria will have to be met by the associate: i) PhD holder (or equivalent), ii) an expertise in line with the job requirements as outlined in the vacancy notice; iii) compliance with transnational mobility criteria as defined in the mobility rule of the Marie Skłodowska Curie Actions (MSCA)⁶⁰.

SMEs can only receive one grant for the whole duration of this topic.

The preferred start date of the innovation associates' employment is in September of the year following the call opening in order to align the timing of the action with the academic year. The execution of the action will start on the starting date of the associates' employment (exact date to be determined during the grant preparation phase).

The innovation associates are expected to be offered employment contracts or equivalent by the hosting SMEs. In return, the innovation associates must commit to a full-time position, for the full duration of the grant.

⁶⁰ Reference to the MSCA mobility rule will be provided at call opening.

DESTINATION 3 – WORLD LEADING DATA AND COMPUTING TECHNOLOGIES

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- KSO A, **‘Promoting an open strategic autonomy 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.’
- KSO C, **‘Making Europe the first digitally led circular, climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems

Proposals for topics under this Destination should set out a credible pathway to contributing to the following expected impact of Cluster 4 as set out in Horizon Europe Strategic Plan:

- **Globally attractive, secure and dynamic data-agile economy**, by developing and enabling the uptake of the next-generation computing and data technologies and infrastructures (including space infrastructure and data), enabling the European single market for data with the corresponding data spaces and a trustworthy artificial intelligence ecosystem.

As data becomes the new fuel of the economy and a key asset to address our societal challenges, the EU cannot afford to have the data of its businesses, public sector and citizens stored and exploited largely outside its borders. This is affecting not only our economic performance but also our security, safety and sovereignty.

As announced in the EU data strategy (COM(2020) 66), the EU has the means to become the world’s most secure and trustful data hub. For that to happen, an important investment effort in the development of data technologies is needed to support the use, interoperability and analytical exploitation of EU-wide common data spaces targeting essential economic sectors and areas of public interest. The COVID-19 crisis showed how essential it is to master data technologies to address our societal challenges and to incentivize public and private stakeholders to trustfully share data.

The investments should cover the necessary data infrastructure and service platforms to enable virtualisation, adaptation of data and meta-data (including standards for data sharing) as well as common analytics tools. Investment in this Destination will reinforce the cloud and data infrastructure supply industry and make data accessible to businesses and governments across the EU in a way that meets European values and requirements. It will focus on energy-efficient and trustworthy data infrastructures and related services. The EU also needs to swiftly develop generic cloud to edge to IoT technologies, methods, tools and platforms for the support of future hyper-distributed applications in any business/societal sector.

Europe's lead in the data economy also increasingly depends on its capability to autonomously develop key High Performance Computing (HPC) technologies, provide access to world-class supercomputing and data infrastructures, maintain global leadership in HPC applications, and foster the acquisition of HPC skills. This is the purpose of the activities funded by the EuroHPC Joint Undertaking.

Investments in this Destination contribute substantially to climate change objectives. Energy efficiency is a key design principle in actions, which will lead to new technologies and solutions that are cornerstones for a sustainable economy and society. These solutions range from environmentally sustainable data operations to balancing loads among centralised clouds and distributed edge computing, from decentralised energy sources to energy-harvesting sensors/devices, etc.

Finally, a robust data ecosystem rests as much on the wide, practical availability of top solutions and results, as on the transparency of the research and innovation process. To ensure trustworthiness and wide adoption by user communities for the benefit of society, actions should promote high standards of transparency and openness. Actions should ensure that the processes and outcomes of research and innovation align with the needs, values and expectations of society, in line with Responsible Research and Innovation.

This Destination is structured into the following headings, which group topics together with similar outcomes to address a common challenge:

- Data sharing in the common European data space

Data sharing and data interoperability are still at their infancy; few data markets for sharing industrial data exist. In a recent survey, more than 40% of the SMEs interviewed claim they had problems in acquiring data from other companies. The diffusion of platforms for data sharing and the availability of interoperable datasets is one of the key success factors which may help to drive the European data economy and industrial transformation. On the other hand, Europe is developing a strong legal framework for data and is well positioned to exploit data from the public sector. The potential of European industrial data (from digitising industry) creates great synergies to feed European data ecosystems with industrial, personal, and public sector data, to be shared and exploited in full compliance with the ethical and legal framework.

In line with the FAIR principles (Findable, Accessible, Interoperable and Reusable), the overall objective of the topics in this heading is to make Europe the most successful area in the world in terms of data sharing and data re-use while respecting the legal framework relating to security and privacy and fostering collaboration and building on existing initiatives.

The topics under this heading are implemented by the co-programmed Partnership 'AI, Data and Robotics'

- Strengthening Europe's data analytics capacity

Recent developments in sensor networks, cyber-physical systems, and the ubiquity of the Internet of Things (IoT) and Artificial Intelligence (AI) have increased the collection of data (including health care, social media, smart communities, industry, manufacturing, education, construction, agriculture, water management finance/insurance, tourism, education, and more) to an enormous scale (by 2025, 463 exabytes of data will be produced every day in the world). There is significant potential for advances of data analytics at the intersection of many scientific, technology and societal fields (e.g. data mining, AI, complex systems, networks, statistics, natural language understanding, mathematics...), and new methods and approaches are needed along the whole data life-cycle and value chain.

The overall objective of the topics in this heading is to make the EU fully autonomous in processing, combining, modelling and analysing such large amounts of data for efficiently predicting future courses of action with high accuracy and advanced decision-making strategies. The use of natural resources is reduced and waste avoided by making it possible to replace classical experiments by data-driven digital models. The technological achievements under this heading will support the development of responsible and useful AI solutions, built on high-quality and high-value data.

- High-end computing for exascale performance and beyond

Today, Europe critically depends on foreign High Performance Computing (HPC) technologies that are essential for scientific and industrial innovation and competitiveness. By 2022 the next generation supercomputers will reach exascale performance, none of them with European technology components.

The overall objective of the topics in this heading is to ensure digital autonomy for Europe in key high-end supercomputing technology (hardware and software) and applications, and developing the first exascale supercomputer based predominantly on European technology by 2026.

Actions in this heading will be entirely implemented in the Joint Undertaking EuroHPC.

- From Cloud to Edge to IoT for European Data

Today, 80% of the processing and analysis of data takes place in data centres and centralised computing facilities, and 20% in smart connected objects; only 1 European company in 4 use cloud technologies; 75% of the European cloud market is dominated by non-EU players. Considering the pace of development in this area outside of the EU, the implementation of the activities will require R&I instruments with great flexibility, including the support of SMEs and start-ups, to nurture a European ecosystem and deliver swift results.

The overall objective of the topics in this heading is to establish the European supply and value chains in cloud to edge computing and tactile internet by integrating relevant elements of computing, connectivity, IoT, AI cybersecurity. New cloud/edge technologies with enhanced performance enabled by AI will increase European autonomy in data processing required to support future hyper-distributed applications.

Activities beyond R&I investments will be needed to realise the expected impacts: testing, experimentation, demonstration, and support for take-up using the capacities, infrastructures, and European Digital Innovation Hubs made available under the Digital Europe Programme; large-scale roll-out of innovative new technologies and solutions (e.g. interconnections between High-Performance Computing centres) via the Connecting Europe Facility; further development of skills and competencies via the European Institute of Innovation and Technology, in particular EIT Digital; upscaling of trainings via the European Social Fund +; and use of financial instruments under the InvestEU Fund for further commercialisation of R&I outcomes.

Expected impact

Proposals for topics under this Destination should set out a credible pathway to contributing to **world-leading data and computing technologies**, and more specifically to one or several of the following impacts:

- Improved European leadership in the global data economy
- Maximised social and economic benefits from the wider and more effective use of data
- Reinforced Europe's ability to manage urgent societal challenges (e.g. data for crisis management).

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

Call	Budgets (EUR million)Deadline(s)
HORIZON-CL4-2021-DATA-01	
HORIZON-CL4-2022-DATA-01	
Overall indicative budget	

Call - WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2021

HORIZON-CL4-2021-DATA-01

Conditions for the Call

Indicative budget(s)⁶¹

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁶²	Number of projects expected to be funded
HORIZON-CL4-2021-DATA-01-01	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-03	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-04	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-05	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-06	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-07	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DATA-01-08	CSA	Around N/A	Not relevant	
Overall indicative budget				

⁶¹ 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 2021 and 2022.

⁶² Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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

Data sharing in the common European data spaces

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DATA-01-01: Technologies and solutions for compliance, privacy preservation, green and responsible data operations (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- improve the efficiency and the use of trustworthy digital technologies to address the requirements of citizens, companies and administrations/public organisations on privacy and commercial and administrative confidentiality as well as responsible, fair and environmentally friendly (e.g. in terms of energy/carbon/material footprint) data operations, across the data life cycle.

Scope: Digital technologies, methods, architectures and processes for safe, trustworthy, compliant, fair, transparent, accountable and environmentally sustainable collection, storage, processing, querying, analytics and delivery of data. The technologies shall facilitate sharing and manipulation of data in compliance with prevailing and emerging legislation (e.g. GDPR) for data processors and data subjects/rightsholders and other stakeholders. The technologies and solutions shall enable safe data handling, sharing and re-use in the context of common European data spaces in various situations and application areas. The scope also includes technologies and solutions that enable environmentally sustainable data operations (e.g. by optimising/minimising/de-centralising processing, transfer and storage of data and avoiding unnecessary data manipulations, using energy-harvesting sensors/devices etc.), as well as technologies and solutions for ensuring human, fair and ethically sound collection, processing and manipulation of data, in line with the principles of responsible/trustworthy AI.

The actions under this topic shall liaise with relevant cyber-security actions under Cluster 3. The actions shall build on Horizon 2020 actions on privacy-preserving technologies and liaise with appropriate actions from Horizon 2020 topic ICT-13-2018-19. They shall also liaise with the Data Spaces Support Centre (to be set up under the Digital Europe programme), in order to provide methods and solutions for the emerging common European data spaces (to be deployed under the Digital Europe programme). Likewise, they shall liaise with other relevant national, regional and trans-national initiatives such as Gaia-X, especially to ensure interoperability and reasonable re-use of common reference models and building blocks for a pan-European data infrastructure.

HORIZON-CL4-2021-DATA-01-03: Technologies for data management (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- provide new secure and energy-efficient data management tools improving the usability and discoverability of data in different contexts, covering data provenance, data quality management (such as data cleaning, validation, enrichment, co-creation, identification of bias and correlations), improving data interoperability, metadata management (automated ways of labelling and describing data, data linkage), and ensuring data security and integrity.

Scope: The actions under this topic are expected to provide practical, robust and scalable tools to improve the interoperability, quality, and integrity of data and metadata, in the context of other topics of the heading “Data sharing in the common European data space”. The data management tools and systems shall support a holistic approach of the data life cycle and comply with the FAIR principles (Findable, Accessible, Interoperable, Reusable) for data and metadata management. Data management tools and systems shall enable, support and/or automate the creation and maintenance of common ontologies, vocabularies and data models and/or structured, standardised and automated authoring, co-creation, curation, annotation and labelling of data, in view of different later uses (especially AI) made of the data. Actions are expected to deal with real-world data heterogeneity challenges (encoding formats, multiple languages, collection mechanisms, access methods, etc.), supporting, where necessary, hybrid/adaptive approaches and models, leading to robust and reliable annotation of unstructured data sources. The tools shall contribute to minimization of the energy footprint, be adaptable to different user needs and support and encourage new business models and (where appropriate) citizen involvement. This shall be demonstrated by diverse use cases.

Strengthening Europe’s data analytics capacity

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DATA-01-04: Extreme data mining, aggregation and analytics technologies (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- provide (technologies, tools and services for data mining (searching and processing) of large, constantly growing amounts and varieties of data, and/or extremely sparse/dispersed/heterogeneous/multilingual data (stored centrally or in distributed systems), in particular IoT and/or industrial/business/administrative/environmental/societal data.

Scope: The actions under this topic are expected to provide ground-breaking advances in the performance (speed and/or, accuracy) and usefulness of data discovery, collection, mining, filtering and processing in view of coping with “extreme data”: (defined as data that exhibits one or more of the following characteristics, to an extent that makes current technologies fail: increasing volume, speed, variety; complexity/diversity/multilinguality of data; the dispersed data sources; sparse/missing/insufficient data). The technologies shall be able to discover and distil meaningful and useful data from heterogeneous and dispersed sources and deliver it to the requesting application/user with minimal delay and in the appropriate format. In particular, the advances shall enable the development of reliable, accurate and fair AI systems where quality of data is as important as quantity and/or support industrial distributed decision-making tasks at appropriate level in the computing continuum (edge/fog/cloud). Insofar the results are intended for human use, the design of these tools must take into account the human aspects.

The actions should address the integration of relevant technologies (e.g. big data, AI, IoT, HPC, edge/fog/cloud computing, language technologies, cybersecurity, telecommunications...) as a means towards achieving the goals, and foster links to the respective research, industrial and user/innovator communities (e.g. AI4EU, digital innovation hubs).

From Cloud to Edge to IoT for European Data

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DATA-01-05: Future European platforms for the Edge: Edge Operating Systems (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Next generation of higher-level operating systems for the smart Internet of Things with strong computing capacity at the smart object and edge-level, embedded in a compute continuum from IoT-to-edge-to-cloud, implementing advanced concepts such as ad-hoc clouds, and time-triggered IoT.
- Increasing European autonomy in data processing required to support future hyper-distributed applications by building open platforms and an open edge ecosystem driven by European actors including business models.
- Achieving trust in these operating systems among actors in diverse industrial ecosystems by leveraging open standards and - where applicable - open source.
- Validated Demonstrators in at least 3 key industrial and societal applications, which in future require more power at the edge.

Scope: Europe needs to strengthen its supply and value chains in cloud to edge computing by integrating relevant elements of computing, connectivity, IoT, AI and cybersecurity. Exploiting network functions of 5G as well as non-cellular networks, the objective is to develop operating systems for the edge that enable cloud and edge computing orchestrations by bringing computation, data and intelligence closer to where the data is produced (sensors and devices) and by which volume, variety, interoperability, and velocity should be handled efficiently and securely. This will make AI inference at the edge viable and lead to a next generation of internet-enabled automation concepts virtualizing computing and networking functions, multi-state analytics and digital twinning of underlying objects to improve end-to-end response time, and to reduce energy consumption.

HORIZON-CL4-2021-DATA-01-06: Programming Environments and Tools for Decentralised Intelligence (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Agile and secure architectures for collaborative smart nodes with decentralised intelligence, which build on European strengths in embedded sensors and devices and wireless communication, both non-cellular and mobile 5G networks.
- Programming environments for smart edge-connected nodes across the device-edge-cloud continuum, which reduce the complexity of programming and maintenance.
- Dynamic open environments and tools, which stimulate open architectures and interfaces, interoperability and avoiding vendor lock-in, open source where appropriate.
- Reinforced Europe's position in the market of next generation smart sensors and devices integrated in an evolving Internet of Things ecosystem with strong capacities at the edge.

Scope: Develop agile and secure architectures, dynamic programming environments and tools for the compute continuum from the device and edge perspective, including AI-based approaches, tools for decentralised device and edge intelligence, innovative mesh topologies and other advanced approaches (tactile internet, swarm intelligence). Research should include actionable data streams and contextual interaction and data fusion between the users and the objects. analytical; model distribution, delocalized computation and new mesh architectures with seamless federation of object identities (IDs) to distributed operation of a large number of heterogeneous IoT devices and systems to achieve higher resilience, security and trust in future services. Validation of systems of smart devices in at least 3 application areas key like for example like farming, utilities, cities and communities, logistics, buildings which in future require more power on device-level at the edge. Contributions to sustainable development goals (SDGs) and open source, if appropriate.

HORIZON-CL4-2021-DATA-01-07: Coordination and Support of the 'Cloud-Edge-IoT' domain (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Support the Commission and the constituency in coordinating the project portfolio and exploring and exploiting synergies between European, national and private initiatives from Cloud to edge to IoT.
- Regain European competitiveness in Internet infrastructures through effective partnership models and the provision of open solutions as well as trusted & interoperable data-driven services in the core and at the edge. There is an explicit need for two CSAs as they must address the topic from two different but complimentary perspectives and target groups – the supply and the demand side.

Scope:

- to coordinate with the evolution of NGI and investments in core Internet infrastructures and support the delivery of interdisciplinary-based new services and applications on top of the cloud-edge-IoT enabled data layer with the potential to generate vast opportunities for entire ecosystems and avoid vendor-lock in at the edge.
- to coordinate, build constituency, and analyse the needs for advanced smart IoT and edge computing nodes and systems in terms of performance, price, energy footprint, real-time capability, security and trust (leveraging cybersecurity research and deployment activities in Cluster 3), needed degree of customisation, etc. – and to map them to existing or emerging solutions, as well as to identify gaps. Outcomes are expected to address the most important sectors for Europe's economy, and competitiveness as well as an analysis of cross cutting aspects like open standards, open source, and synergies across sectors.

HORIZON-CL4-2021-DATA-01-08: Roadmap for next generation computing and systems technologies (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Support structure for the European Computing ecosystem: networking events and vision workshops for the academic and industrial computing community,

- Yearly updated roadmaps on computing addressing the area from a broad perspective from edge device to edge cloud to cloud to HPC, from scientific to industrial to societal and research applications, and addressing all relevant aspects such as real-time, security, etc.

Scope: To support the European Commission and the European computing constituency by providing to them annually updated roadmaps for research and innovation related to computing. This topic is overarching and building the bridge between Destinations 3 (heading “From Cloud to Edge to IoT for European Data”), Destination 4 (“Ultra Low Power Processors”), as well as the Joint Undertakings on Key Digital Technologies, Smart Networks and Services, and high-performance computing (HPC). This effort builds on the achievements and structures established by the HIPEAC project and think tank of all renowned European research centres on computing “at large” and their key experts. Both the academic visions as well as the industrial perspective should be taken into account.

Call - WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2022

HORIZON-CL4-2022-DATA-01

Conditions for the Call

Indicative budget(s)⁶³

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁶⁴	Number of projects expected to be funded
HORIZON-CL4-2022-DATA-01-01	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DATA-01-02	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DATA-01-03	IA	Around N/A	Not relevant	

⁶³ 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 2021 and 2022.

⁶⁴ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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Digital, Industry and Space

HORIZON-CL4-2022-DATA-01-04	IA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Data sharing in the common European data spaces

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DATA-01-04: Technologies and solutions for data trading, monetizing, exchange and interoperability (IA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

improve the digital technologies, solutions and interoperable frameworks for data markets and data economy (e.g. industrial, administrative and societal/cultural data platforms/data spaces), allowing for data assets to be discoverable, efficiently and fairly priced and shared/traded in a secured, compliant and energy-efficient way; promote the development of a European industrial ecosystem of the data economy capable of ensuring digital autonomy.

Scope: The focus is on technologies, solutions and frameworks that facilitate the collection, sharing, storing, processing, trading and re-using of data in compliance with the legal framework and satisfying the needs, expectations and rights of the data providers, brokers, users and data subjects. Practical and scalable solutions for handling large amounts of transactions while minimizing energy consumption are necessary (e.g. smart/automated contracting, data rights management, tracking of subsequent data use). Special attention should be paid to fostering approaches that ensure data and metadata interoperability, including the application of appropriate standards, reference architectures, common ontologies/vocabularies/data models allowing smooth data sharing (also across sectors). The emphasis is on the development and demonstration of practical and mature end-to-end systems, building on the results of work on data platforms (topic H2020-ICT-13-2018-2019), privacy-preserving technologies and computing technologies under Horizon 2020 and this programme.

Actions are expected to develop and/or support data spaces of realistic scope and size, deployable in real-world applications in various application areas. In particular, the actions are expected to support the deployment of the Common European Data Spaces under the Digital Europe programme (notably via the Data Spaces Support Centre, to be set up under the Digital Europe programme): the technologies and tools are developed under Horizon Europe actions and the deployment and operations are supported under Digital Europe actions. The actions are expected to build on and create links with other European data sharing schemes (e.g. EOSC, META-SHARE, ELRC-SHARE, European Data Portal), and potential/emerging data user/innovator communities (e.g. AI4EU, digital innovation hubs), as appropriate. The actions shall contribute to European technological autonomy in data sharing.

Strengthening Europe's data analytics capacity

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DATA-01-01: Methods for exploiting data and knowledge for extremely precise outcomes (analysis, prediction, decision support), reducing complexity and presenting insights in understandable way (RIA)

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- automated ways for extracting meaning and providing insights from data extremely fast and/or accurately in order to optimize decision making (ranging from crisis/emergency management to predictive maintenance).

Scope: The actions under this topic are expected to exploit “extreme data”: (defined as data that exhibits one or more of the following characteristics, to an extent that makes current technologies fail: increasing volume, speed, variety; complexity/diversity/multilinguality of data; the dispersed data sources; sparse/missing/insufficient data) to push the frontiers of analytics, prediction, simulation and visualisation to provide extremely precise, timely and useful results from data and knowledge, to support (human or automated) decision-making, saving lives or providing great positive impact (economic, societal, environmental) compared to traditional methods of decision making. Integrity and ethical aspects of the outcomes should be in line with the principles of responsible/trustworthy AI. *Analytics* should be transparent, flexible, fit for the purpose and user needs, intuitive and (when necessary) provided as efficient and scalable “Analytics-as-a-Service”, including, where appropriate, federated analytics on distributed/decentralized data. *Prediction* should be extremely precise and/or span over longer time period and/or account for uncertainty factors. *Simulation* should allow precise replication and modelling of the real phenomenon or system (generating accurate synthetic data, when appropriate), with minimal differences and/or minimize the footprint/cost of the simulation model while generating useful data, exploiting augmented reality when appropriate. Actions should consider quality standards and assessment criteria for data generated by simulation. *Visualisation* should be interactive (and facilitate human interaction and collaboration), intuitive, accessible and allow people (with different needs, interests and backgrounds) to understand complex phenomena by smart selection of parameters, anticipation of user needs/interest and by novel ways of combining visual and non-visual elements and/or augmented reality.

From Cloud to Edge to IoT for European Data

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DATA-01-02: Cognitive Cloud: AI-enabled computing continuum from Cloud to Edge (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- A new AI-enabled Cloud-edge framework that will automatically adapt to the growing complexity and data deluge by integrating seamlessly and securely diverse computing and data environments, spanning from core cloud to edge. This framework will respond and adapt intelligently to changes in application behaviour and data variability offering automatic deployment, mobility and adaptability of services from cloud to edge to diverse users and contexts. The Cognitive Cloud will interface with all the layers in the computing continuum plane and will learn through the monitoring and management of resources deployed on Cloud/Edge. Applying AI-techniques will cater for dynamic load balancing to optimise energy efficiency and maintaining balanced data traffic and high, distributed, reliable throughput from cloud to edge according to the application and user needs and the underlying infrastructures. Application developers will be empowered with greater control over network, computing and data infrastructures and services, and the end-user will benefit from seamless access to a continuous service environment.

Scope: Highly innovation cloud management layer making the best application of artificial intelligence techniques and AI models with automatic adaptation to the computing resources in cloud and edge to optimize where data are being processed (e.g. very close to the user at the edge, or in centralised capacities in the cloud). Seamless integration of diverse computing and data environments spanning from core cloud to edge, in an AI-enabled computing continuum. Automatic adaptation to the growing complexity of requirements and the exponential increase of data driven by IoT deployment across sectors, users and contexts while achieving optimal use of resources, holistic security and data privacy and credibility. Interoperability challenges among computing and data platform providers should be addressed and cloud federation approaches (based on open standards and open platform) should be considered where appropriate.

HORIZON-CL4-2022-DATA-01-03: Emerging smart industrial internet of things and edge computing systems (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Improvement and up-take of emerging EU-driven smart industrial internet of things (IIoT) and edge computing systems with a reduced energy footprint to perform under real life conditions, demonstrate adoption in key applications and sectors crucial for Europe's competitiveness and strategic autonomy.
- Bridge between European actors on demand and supply side to gain back territory from hyper-scalars dominating today's cloud data processing market, avoiding vendor lock-in.
- Establish open platforms for smart IIoT and edge computing systems exploring open interfaces, being standardised with relevant standardisation bodies.
- Emergence of an open edge ecosystem including midcaps, SMEs and start-ups that foster edge solutions, which represent a modular functional spectrum of executable apps and services critical to establishing a mature European supply chain under challenging and extremely competitive market conditions.

Scope: Considering the exponential growth of connected devices and systems, data processing and analytics at the edge will become the engine for industrial transformation. Edge computing systems shall create value in orchestrating multi-tiered data processing with control and automation on the edge, minimizing energy footprint, taking advantage from decentralised energy sources, stimulating multi-sided marketplaces, and fostering open standards for virtualization, interoperability, and secure and trusted data sharing across the value chain – both horizontally and vertically. Innovation Actions are used to customise, explore the limits, test, optimise and validate emerging European smart IoT and edge computing systems under the constraints of industrial mass-market applications such as network connectivity, performance, cost, data processing latency for analytics and AI-inference at the edge, real-time capabilities, scalability, trust and security, interoperability, etc. Use cases shall demonstrate open, trusted & interoperable data-driven services close to the

users, which particularly profit from power and customisation at the edge, taking a system-level approach from hardware to application. Use cases may include autonomous driving, manufacturing, energy and other utilities, buildings, and farming, etc..

Instruments:

IAs,

FSTP

Proposals are expected to use financial support to third parties (FSTP) to support industry, in particular SMEs, in take-up of emerging edge topologies, for populating and validating relevant use cases through experiments. A maximum of 20% of the budget is expected to be dedicated to FSTP and the maximum amount of FSTP is EUR 200.000 per third party for the entire duration of the action.

DRAFT

DESTINATION 4 – DIGITAL AND EMERGING TECHNOLOGIES FOR COMPETITIVENESS AND FIT FOR THE GREEN DEAL

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- KSO A, ‘**Promoting an open strategic autonomy 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.’
- KSO C, ‘**Making Europe the first digitally led circular, climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems

Proposals for topics under this Destination should set out a credible pathway to contributing to the following expected impact:

- **Sovereignty in digital technologies and in future emerging enabling technologies**, by strengthening European capacities in key parts of digital and future supply chains, allowing agile responses to urgent needs, and by investing in early discovery and industrial uptake of new technologies.

Electronic and photonic components, and the software that defines how they work, are the key digital technologies that underpin all digital systems. As the digitalisation of all sectors accelerates, most industries depend on early access to digital components. Dependence on these technologies represents a clear threat to Europe’s autonomy, particularly in periods of geopolitical instability, exposing Europe to risks of vulnerability. Actions under this Destination will Building on EU strengths in low-power consumption and ultra-secure components, Europe needs to develop the essential electronic and photonic components for a wide range of applications such as healthcare equipment, electric and autonomous vehicles, manufacturing plants, telecom networks, aerospace vehicles.

R&I initiatives on 6G technologies are now starting in leading regions world-wide, with the first products and infrastructures expected for the end of this decade. 6G systems are expected to offer a new step change in performance from Gigabit towards Terabit capacities and sub-millisecond response times, to enable new critical applications such as real-time automation or extended reality (“Internet of Senses”). Europe must engage now to be among the top influencers of - and competitors in - these technologies and ensure that emerging network technology standards are defined following European values and energy-efficiency requirements.

Despite a strong European scientific community’s on AI and robotics, Europe lags behind in AI diffusion. Actions under this Destination will develop world-class technologies serving the needs of all types of European industries (e.g. manufacturing, healthcare, transport,

agriculture, energy, construction), providing top-performing solutions that businesses will trust and adopt to maintain their competitiveness and maximise their contribution to environmental sustainability.

While Europe is strong in many sectors, it must take ownership of its unavoidable future transformations for competitiveness, prosperity and sustainability, by early leadership in new and emerging enabling technologies, e.g. alternative computing models such as bio- and neuro-morphic approaches, use of biological elements as part of technology, and sustainable smart materials. In particular, the far-reaching impact of quantum and graphene technologies on our economy and society cannot be fully estimated yet, but they will be disruptive for many fields. Actions in this Destination will ensure that Europe stays ahead in this global race and is in a position to achieve game-changing breakthroughs.

Actions under this Destination will support Europe's strategic autonomy, and reinforce and regain European industry's leaderships across the digital supply chain. It will direct investments to activities that will ensure a robust European industrial and technology presence in all key parts of a greener digital supply chain, from low-power components to advanced systems, future networks, new data technologies and platforms. Autonomy will require sustaining first-mover advantage in strategic areas like quantum computing and graphene, and investing early in emerging enabling technologies.

Investments in this Destination contribute substantially to climate change objectives. Energy efficiency is a key design principle in actions, which will lead to new technologies and solutions that are cornerstones for a sustainable economy and society. These solutions range from ultra-low-power processors to AI, data and robotics solutions for resource optimisation and reduction of energy consumption and CO₂ emissions; from highly efficient optical networking technologies and ultra-low-energy 6G communication networks to robotics that overcome the limitation of energy autonomy. Furthermore, promising emerging avenues are addressed via ultra-low power operations enabled by spintronics and 2D materials-based devices and systems for energy storage and harvesting.

Actions should devote particular attention to openness of the solutions and results, and transparency of the research and innovation process. To ensure trustworthiness and wide adoption by user communities for the benefit of society, actions should promote high standards of transparency and openness. Actions should ensure that the processes and outcomes of research and innovation align with the needs, values and expectations of society, in line with Responsible Research and Innovation.

As a result, this Destination is structured into the following headings, which group topics together with similar outcomes to address a common challenge:

- Ultra-low power processors

Today Europe is not highly present in the microprocessor market. The objective of this heading is to ensure EU strategic autonomy through the development of low-power, low environmental impact, secure and trusted components and software for strategic value-chains.

Proposals are invited under the topics of this heading in this work programme and under the topics of the ‘Key Digital Technologies’ Joint Undertaking addressing the electronics value chain (including software technologies).

- European Innovation Leadership in Electronics

Europe currently has a leading position in key digital technologies for the strategic sectors of automotive, industrial manufacturing, aerospace, defence and security and healthcare. In the emerging area of post-Moore components, there is a number of promising technological approaches with no established players or dominant regions.

The objective of this heading is to secure access in Europe to cutting-edge digital technologies, to strengthen current leadership in strategic value-chains, and to seize emerging opportunities addressing existing technological gaps.

Proposals are invited under the topics of this heading in this work programme and under the topics of the ‘Key Digital Technologies’ Joint Undertaking addressing the electronics value chain (including software technologies).

- European Innovation Leadership in Photonics

The European photonics industry has an excellent position in core segments, far above the average EU market share. The objective of the topics grouped in this heading is to strengthen current leadership in photonic technologies and applications, and to secure access in Europe to cutting-edge photonic technologies.

The topics of this heading are under the co-programmed Partnership ‘Photonics’.

- 6G and foundational connectivity technologies

Today European suppliers of connectivity systems are well placed with around 40% of global 5G market share, but with high competitive pressure from Asian and US players. In terms of technology, first 5G standards are available since end of 2017 enabling Gigabit/s speeds and ~millisecond latencies. Trusted industrial services based on 5G technology are at very early stage.

The objective of this heading is to develop a strong supply chain for connectivity, increase European competitiveness and autonomy in Internet infrastructures, and to contribute to a reduction of the growing global energy consumption of the Internet and of the industry vertical users of the Internet, and to other key SDG’s such as affordability and accessibility to infrastructures. The topics in this work programme address in particular.

Proposals are invited under the topics of this heading in this work programme (addressing foundational technologies, long term, very high risk and disruptive concepts on radio and full optical networks as well as new IoT real-time concepts) and under the topics of the ‘Smart Networks and services’ Joint Undertaking.

- Innovation in AI, data and robotics

Europe has an outstanding track record in key areas of AI research, Europe's scientific community is leading in AI and robotics, but substantial efforts are needed to transform this into (disruptive) European AI technology products that can withstand international competitors. Europe also lags behind in technology diffusion, less than half of European firms have adopted AI technology, with a majority of those still in the pilot stage. 70% of these adopter companies, only capture 10% of full potential use, and only 2% percent of European firms in healthcare are using those technologies at 80% of potential⁶⁵. Moreover, as demonstrated during the COVID-19 crisis, many AI, data and robotics solutions exist today but only a limited number of them reaches the level of maturity and adoption necessary to solve the problems at hand. Therefore, there is room for improved adoption by industry, which requires a drastic increase of industry-driven R&I, from basic research to large-scale piloting. In general, industry acknowledges the potential of AI technologies, but often lacks demonstrable benefits for their particular use cases.

The objective of this heading is to ensure autonomy for Europe in AI, data and robotics in developing world-class technologies serving the needs of all types of European industries, from manufacturing to healthcare, public sector, utilities, retail, finance, insurance, transport, agriculture, energy, telecommunications, environmental monitoring, construction, media, creative and cultural industries, fashion, tourism, etc. providing top-performing solutions that industries will trust and adopt to maintain their competitiveness and maximise their contribution to environmental and resources sustainability.

Topics xx of this heading are under the co-programmed Partnership 'AI, Data and Robotics'.

- Tomorrow's deployable Robots: efficient, robust, safe, adaptive and trusted

Europe is leading in robotics industry, with a high intensity of use of robots. Europe is also scientifically leading in robotics' cognition, safety, manipulation, soft robotics, underwater and aerial robotics, with demonstrated impacts in many use-cases in key industrial sectors (e.g.: healthcare, agrifood⁶⁶, forestry, inspection and maintenance, logistics, construction, manufacturing, etc.) and across multiple modalities (aerial, marine, ground, in-vivo and space).

The objective of this heading is to ensure autonomy for Europe in robotics, leading the way in research, development and deployment of world-class technologies.

Topics xx of this heading are under the co-programmed Partnership 'AI, Data and Robotics'.

- European leadership in Emerging Enabling Technologies

⁶⁵ See <https://www.mckinsey.com/featured-insights/artificial-intelligence/tackling-europes-gap-in-digital-and-ai> (based on data from 2017 and 2018)

⁶⁶ The term Agri-Food is intended to cover a wide range of food production sectors including livestock farming, fisheries, horticulture etc as well as produce processing, ingredient preparation and food manufacture and assembly.

Europe's leading industry sectors have a solid track-record in constant improvement, but less so for embracing transformative ideas. The pathway from research to industry uptake is often long and staged, with no intertwining of research and industry agendas. In the age of deep-tech, though, this intertwining is essential.

The objective of this heading is to identify early technologies that have the potential to become Europe's future leading technologies in all areas of this cluster and to establish industry leadership in these technologies from the outset. This heading has a unique focus on off-roadmap transformations with a longer time-horizon but profound potential impact.

- Flagship on Quantum Technologies: a Paradigm Shift

Since 2018, the Quantum Technologies Flagship has been consolidating and expanding Europe's scientific leadership and excellence in quantum, in order to foster the development of a competitive quantum industrial and research ecosystem in Europe. The EU's aims for quantum R&I in the next decade are set out in detail in the Quantum Flagship's Strategic Research Agenda (SRA⁶⁷) and its associated main Key Performance Indicators,⁶⁸ which drafted and published in 2020 on quantum computing, quantum simulation, quantum communication, and quantum sensing and metrology. Projects in each of these areas are currently supported by the Flagship, by other EU research initiatives and by national programmes.

The objective of this heading is to further develop quantum technologies and their applications in the areas of quantum computing, simulation, sensing and communication, in order to strengthen European technological sovereignty in this strategic field and achieve first-mover industry leadership, capitalising on Europe's established excellence in quantum science and technology maintaining and developing quantum competences and skills available in the EU and raising the capabilities of all Member States in this field.

- Graphene: Europe in the lead

The starting point is the Graphene Flagship, launched in 2013, which already reached European leadership in graphene and related 2D materials. The work is now coming to a critical point where first simple products are being launched. R&I activities would now need to be pursued and accelerated in order to translate achieved technology advances that are at TRL 4-5 into concrete innovation opportunities and into production capabilities in many industrial sectors (e.g. aviation, automotive, electronics, batteries, healthcare).

The objective of this heading is to strengthen and accelerate the technology developments that support a strong European supply and value chain in graphene and related materials and provide first-mover market advantages of scale.

Activities beyond R&I investments will be needed to realise the expected impacts: testing, experimentation, demonstration, and support for take-up using the capacities, infrastructures,

⁶⁷ https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=65402

⁶⁸ Link to provide later

and European Digital Innovation Hubs made available under the Digital Europe Programme; large-scale roll-out of innovative new technologies and solutions (e.g. new energy-efficient connectivity technologies) via the Connecting Europe Facility; further development of skills and competencies via the European Institute of Innovation and Technology, in particular EIT Digital; upscaling of trainings via the European Social Fund +; and use of financial instruments under the InvestEU Fund for further commercialisation of R&I outcomes.

Expected impact

Proposals for topics under this Destination should set out a credible pathway to contributing to **digital and emerging technologies for competitiveness and fit for the Green Deal**, and more specifically to one or several of the following impacts:

- Europe's strategic autonomy by sustaining first-mover advantages in strategic areas including AI, quantum computing, and graphene, and by investing early in emerging enabling technologies.
- Reinforced European industry leadership across the digital supply chain.
- Robust European industrial and technology presence in all key parts of a greener digital supply chain, from low-power components to advanced systems, future networks, new data technologies and platforms.

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

Call	Budgets (EUR million)Deadline(s)
HORIZON-CL4-2021-DIGITAL-EMERGING-01	
HORIZON-CL4-DIGITAL-EMERGING-2022-01	
Overall indicative budget	

Call - Digital and emerging technologies for competitiveness and fit for the green deal

HORIZON-CL4-2021-DIGITAL-EMERGING-01

Conditions for the Call

Indicative budget(s)⁶⁹

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁷⁰	Number of projects expected to be funded
HORIZON-CL4-2021-DIGITAL-EMERGING-01-01	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-05	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-06	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-07	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-09	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-10	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-11	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-	RIA	Around	Not	

⁶⁹ 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 2021 and 2022.

⁷⁰ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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Digital, Industry and Space

EMERGING-01-12		N/A	relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-13	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-14	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-15	HORIZON-FPA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-17	HORIZON-FPA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-19	HORIZON-FPA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-20	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-21	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-22	HORIZON-FPA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-23	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-24	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-25	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-26	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-27	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-30	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-31	RIA	Around N/A	Not relevant	
Overall indicative budget				

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

Ultra-low power processors

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-01: Ultra-low-power, secure processors for edge computing (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Develop European secure specialised microprocessor designs (including accelerators and controllers) that deliver high-performance computing at ultra-low power operation.

- Improve by at least two orders of magnitude the performance per watt for the targeted edge applications

Scope:

- Develop European specialised processors, architectures and computational engines that have the potential to substantially improve energy efficiency (i.e. performance per watt) for the targeted edge application.
- Examples of targeted applications (non-exhaustive list) are automated driving, artificial intelligence, machine learning, computer vision, machine translation, speech recognition, sensor fusion, etc.
- New specialised processor designs may incorporate approaches such as neuromorphic, in-memory computing, neural networks as well as open-source hardware and processor IP.
- Projects should have a longer-term perspective taking into account the reduced performance improvements of general-purpose computing, the slow-down of Moore's law and the changing economics of semiconductor manufacturing.
- Projects should include research on advanced hardware-based security at silicon-level.

Projects should include a preliminary analysis of bringing successfully to the market the proposed research either as IP blocks or as standalone chips. Projects may include early chip prototyping in well-justified cases.

The EU estimates that an EU contribution of up to EUR 10 million per project would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting different amounts.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-05: Open Source Hardware for ultra-low-power, secure processors (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Structure European involvement in open source hardware efforts (including open Instruction Set Architectures) related to the design of ultra-low-power, secure microprocessors, microcontrollers and accelerators.
- Develop a roadmap for open source hardware in Europe covering both R&D as well as funding & business aspects for edge applications in all power and performance ranges from deeply embedded to high-end computing.

Scope:

- Address issues like availability of a sustainable and reliable open hardware IP supply, maturity of the IP components (especially for industrial use), open source design tools, compilation, simulation, verification, real-time and mixed criticality, etc.
- Bring together all relevant European stakeholders and further develop and grow the European open source hardware ecosystem
- Align with related regional or national initiatives covering both academia and industry
- Interface with international efforts in the area.
- Participate and lead in the development of open source hardware standards and specifications

European Innovation Leadership in Electronics

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-31: Functional electronics for green and circular economy (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- Development of new concepts, designs and technologies to support and enable circular economy and sustainability in electronics.
- Development of next generation components and systems that will deliver climate-neutral digital solutions for a wide range of sectors.

Scope: Proposals are expected to make technological breakthroughs in the development of functional electronics technologies⁷¹ to address the challenges and opportunities associated with green and digital transformation. Eco-design principles⁷², in particular reduction of energy and resource consumption should be taken into account. The emphasis of this topic will be on the advancement in the area of flexible, printed and organic electronics as low-cost/light weight/less energy intensive approach to complement inorganic-based mainstream semiconductors.

It is expected that projects will focus on the activities related to:

- Development of beyond state-of-the-art processes for electronic components and systems by making use of different types of substrates (e.g. flexible, stretchable and conformable) and their integration in various structures and materials (e.g. textiles, plastics, glass, paper and metal). Projects should address improvement of system characteristics (e.g. performance, robustness, reliability) and progress in high throughput/low-cost manufacturing processes.
- Increasing capability to integrate flexible and printed electronics in various application domains (e.g. wearables, mobility, health/well-being, agriculture and environment, energy and smart logistics) or/and in hybrid IC/flexible systems.
- Activities related to the development of new methodologies for next generation components and systems taking into account Eco-design principles, such as more efficient recovery and recycling solutions or/and optimisation of the use of resources (e.g. energy efficiency at system and manufacturing level, material consumption) will be encouraged.

Issues related to life cycle, end-of life, standardisation, certification and regulation compliance should be considered whenever appropriate.

Proposals should include targets and metrics for decreasing use of resources in their chosen approaches.

Projects are expected to address the TRLs 2-4.

European Innovation Leadership in Photonics

Proposals are invited against the following topic(s):

⁷¹ Area at the convergence of unconventional nano-electronics, flexible/printed electronics and electronic smart systems that enables shifting from purely physical integration to functional integration

⁷² Complying with the EU Ecodesign directive

HORIZON-CL4-2021-DIGITAL-EMERGING-01-06: Advanced optical communication components (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Reliable and low latency communication with guaranteed service quality for the digital transformation of industrial processes;
- Reduced congestion in data communication when a multiplicity of applications compete for simultaneous delivery, thereby causing data loss or a delay in data delivery;
- Reduced power consumption to some pico-Joule per bit through the broader use of optical networking technologies, interconnects, and integrated optical communication components;
- Lowered barrier for the uptake of performant communication technologies by reducing cost of transmission interfaces to around 50 cents per Gigabit per second.

Scope: Projects to develop ultra-dynamic photonic components and subsystems for data communication, using for example new optical wavelength bands, space division multiplexing, new integration schemes, optical switching and new switching paradigms, as solutions for time-deterministic and time-sensitive networks. They should also enable ultra-dynamic reconfiguration on the optical layer and mitigate amplifier power transients, while saving energy, improving bandwidth efficiency, and guaranteeing low deterministic latencies across the network.

Advances will cover a range of use cases for example from optical switching in commercial applications to optical flow or packet switching approaches that would become practical for the industrial Internet. Where relevant for the application, devices should be able to work in a harsh environment such as within a wide temperature operating range, or in high humidity.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-07: Disruptive solutions for integrated photonics, PICs and hybrid technologies (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- New generations of integrated devices enabled by core technologies and technology building blocks.
- Strengthening industrial capability of photonic device fabrication by integration and miniaturisation of technologies
- Lowering the barrier to the use of advanced or innovative photonic integration technologies for companies, in particular high-tech SMEs

Scope: Evolving photonic integration is opening up a wealth of opportunities in many application areas by enhancing functionality and spectral coverage, facilitating new applications in biomedical, environmental, industrial and sensing fields, making devices more power-efficient and bringing ground-breaking technologies within reach of entrepreneurial SMEs.

The increasingly sophisticated requirements need new paradigms, capable of extending the functionalities of optical components through new materials, design, fabrication, assembly and packaging techniques including the co-integration of photonic and electronic components. These need to be augmented with new functions and performance enhancements, requiring in many cases the development of new semiconductor materials and innovative device structures.

Challenges are for example in mastering epitaxial material growth and processing on large wafers with improved quality, uniformity and very low defect densities, broadband (“white”) light sources and high sensitivity avalanche photodetectors (including arrays) and high-efficiency semiconductor lasers operating at high temperatures (>85°C) across many wavelength bands. Incorporation of new building blocks such as magneto-optic elements for non-reciprocal functionality (e.g. optical isolation) could also be included.

Projects should demonstrate the developed integration technologies in at least two application oriented use cases and establish integration platforms, which help potential user companies with their uptake.

6G and foundational connectivity technologies

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-26: Coordination of European Smart Network actions (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome:

One project expected to contribute to the following expected outcomes:

- Establishment of a Europe wide platform addressing the Communication Network Technologies and systems supporting the identification of strategic R&I orientations including at global level the coordination of R&I results/initiatives at EU scale including Member State level initiatives, the dissemination and web presence, the organisation of contribution to standards, the organisation of international cooperation across key regions.

Scope:

The selected project covers:

- Stakeholders management towards R&I gaps identification and projects coordination;
- Europe wide cartography of relevant Smart Network initiatives
- Design and maintenance of a European network web site
- Working groups management and organisation for issues of common interests;
- International cooperation support with key third countries;

- Support to organisation of key conferences and dissemination events

Type of Action: CSA

Innovation in AI, data and robotics

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-09: AI, data and Robotics for the Green Deal (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Innovative AI, data and robotics solutions for resource optimisation and minimisation of waste in any type of sector (from agrifood, to energy, utilities, transport, production, etc.), reduction of energy consumption and CO2 emission including exploitation of all data and information sources contributing to optimising applications for a greener planet. This includes among other contribution to enterprises' sustainability programs in the context of their CSR (Corporate Social Responsibility) strategies to reduce their ecological footprint, cutting costs and contributing to social welfare at the same time
- Optimised AI, data and robotics (including modular and adaptive solutions) to maximise contribution to the Green Deal in various applications such as environmental and waste management, including for instance waste clean-up (e.g. plastic collection, sorting), or in the circular economy value chain.
- Advanced physical intelligence and physical performance of robotics solutions in diverse harsh environments serving the Green Deal

Scope:

Proposals are expected to integrate and optimise AI, data and robotics solutions in order to demonstrate in use-cases scenarios in real or close-to-real environments, how they can directly contribute to the Green Deal. Methodology should be supported by industry or

service relevant KPIs, making the case for the added value of such technologies, and demonstrating scalability, and deployment potential. Technology performance as well as added value to the application field should be demonstrated by qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring.

While the proposals must be application driven, involving problem owners to define needs and validate the proposed solutions, the focus is on optimising enabling AI, data and robotics technologies to maximise the benefit they bring. Proposals should adopt a concrete problem solving approach, exploiting and optimising the most suitable technologies and solutions at hand. The focus should be on real-world scenarios which can benefit in short to mid-term from the technology and solutions and demonstrate substantial impact on the Green Deal, while taking into account the maturity of the technologies to solve the problems at hand.

Deep involvement of all relevant stakeholders, from technology providers to user industry, social partners, and relevant experts in operational and environmental impact assessment, will be essential. Special attention will be given to including users of diverse age, gender and background.

All projects should incorporate training programs for non-expert users of AI, data and robotics systems, who are domain experts and need to know basic AI, data, robotics concepts, including the basics concepts of AI-ethics.

Proposals can involve either robotics-only solutions (for instance demonstrating robotics solutions in harsh environments), or a mix of robotics and non-robotics components (for instance in applications such as waste management, where a combination of robotics for waste segregation and data/sensor driven AI for process optimisation) or only include non-robotics AI (for instance in energy optimisation, from production sites, through the network, and then end-user sites, with IoT components). All selected proposals are expected to include demonstrators at TRL 6 or above. At least half of the selected proposals will have to have a major robotics demonstrator.

Proposal should clearly identify the expected outcome it will focus on. To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but at least 2 highest ranked for each of the expected outcome (1. Resource optimisation and minimisation of waste/energy/CO2 emission, 2. Environmental and waste management in the circular economy, 3. Robotics solutions in harsh environments serving the Green Deal) provided that the applications attain all thresholds.

Two types of proposals are expected:

1. Focused projects involving the user industry and technology provider(s),
2. Larger projects where a number of companies in a given application sector will identify in the proposal common challenges and use-cases, and organise competitive calls for AI, data and robotics solution providers to address such challenges. Competitive calls will be

open to any kind of companies, but SMEs and Start-ups⁷³ will receive financial support via FSTP, with a maximum of 200k€ per third party and 70% funding (100% for start-ups). At least 40% of the funding should be dedicated to FSTP funding. The consortium will provide technical support with expertise in engineering integration, testing and validation to support the selected SMEs and start-ups acting as technology providers to demonstrate the added value of their solutions to address the challenges of the use-cases.

In all proposals, user industries are expected to play a major role in the requirement and validation phases.

Besides financial support, these SMEs and start-ups successfully demonstrating the potential of their solutions, will receive support from business experts to further develop their business and develop their market reach, and maximise their business opportunities.

All proposals should build on and reuse public results from relevant previous funded actions. Projects should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform⁷⁴, Digital Industrial Platform for Robotics⁷⁵, data platforms⁷⁶ and, if necessary other relevant digital resource platforms. Communicable results from selected proposals should be delivered to the most relevant of these platforms in order to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice. This topic implements the co-programmed European Partnership on AI, Data and Robotics.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-10: AI, data and Robotics at work (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

⁷³ *In this context a start-up is a tech-oriented company. It should employ less than 10 people (but more than 2 full time equivalent staff) that has operated for less than three years and has attracted more than €50k early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% FTSP while other SMEs would receive 70% funding. Startups would be expected to highlight the impact that the project will have on their overall Company strategy and growth prospects in the Impact section of their proposals (as well as the impact on society and European competitiveness.*

⁷⁴ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁷⁵ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

⁷⁶ E.g.: <https://www.big-data-europe.eu/>

Expected Outcome:

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

- A new human-centred paradigm to keep people away from unsafe and unhealthy jobs via collaborative embodied (physical) AI, engaging and empowering end-users and workers, regardless of their gender, age or background.
- Human-centric AI supporting professionals in decision-making, and optimising their tasks

Scope:

Proposals are expected to demonstrate how AI, data and robotics solutions can support workers in their daily tasks, improving working conditions and work performance/efficiency, while considering safety, security and resilience, as appropriate. The added value to the application field should be demonstrated by qualitative and quantitative industry or service relevant KPIs, demonstrators at TRL6 or above, benchmarking and progress monitoring processes.

The involvement of the application sector stakeholders, including social partners, workers, managers and decision makers must be a key driver in the proposals, not only to identify the needs and the application scenarios, but to be involved in the co-creation and testing and uptake of the solutions and providing feedback to adapt the solutions to optimise the impact on working conditions and performances.

The selection of the application sector should prioritise sectors and use-cases where the technology can demonstrate maximum impact and added value.

A human-centred approach will be key, with involvement of the workers, professionals, (front-line operators and managers) and other relevant experts in human-centred design. They will closely collaborate with the technology providers and integrators. Engagement with SSH expertise is also needed to improve interaction design and to provide expertise on trustworthiness and acceptability by workers. Gender and intersectionality dimension analysis should be a part of the proposals, where relevant.

Each proposal will focus on one of the following use-cases:

- Collaborative embodied AI (robotics system), empowering end-users and workers keeping them away from unsafe and unhealthy jobs: the focus will be on demonstrating improved working conditions (health/safety/level of stress, etc.), and worker trust and acceptance. Meaningful human oversight of autonomy should be addressed.
- AI and data supporting professionals in trustworthy hybrid decision-making and supporting workers to optimise and facilitate their tasks; the focus will be on demonstrating how AI and data can improve the effectiveness and efficiency as well as management of trade-offs within the decision-making, building on the human and

machine complementarities, exploiting the best capability of both for a better outcome. Meaningful human oversight of decision outcomes should be addressed. Specific effort should be made to develop re-usable decision-support systems or modules.

All proposals should exploit the latest results in AI, data and robotics, as well as multimodal interaction technologies, UiX (User interface experience), for natural and seamless interaction between the human and the technology/sources of information, including Augmented/Virtual Reality when appropriate.

All proposals should incorporate skills developments activities or/and connect with existing skills activities going on in that domain, as appropriate.

Proposal should clearly identify the use-case listed above it will focus on. To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but at least 2 highest ranked for each use-case, provided that the applications attain all thresholds.

Two types of proposals are expected:

1. Focused projects involving the user industry and technology provider(s),
2. Larger projects where a number of companies in a given application sector will identify in the proposal common challenges and use-cases, and organise competitive calls for AI, data and robotics solution providers to address such challenges. Competitive calls will be open to any kind of companies, but SMEs and Start-ups⁷⁷ will receive financial support via FSTP, with a maximum of 200k€ per third party and 70% funding (100% for start-ups). At least 40% of the funding should be dedicated to FSTP funding. The consortium will provide technical support with expertise in engineering integration, testing and validation to support the selected SMEs and start-ups acting as technology providers to demonstrate the added value of their solutions to address the challenges of the use-cases.

In all proposals, user industries are expected to play a major role in the requirement and validation phases.

Besides financial support, these SMEs and start-ups successfully demonstrating the potential of their solutions, will receive support from business experts to further develop their business and develop their market reach, and maximise their business opportunities.

All proposals should build on and reuse public results from relevant previous funded actions. Proposals should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources

⁷⁷ *In this context a start-up is a tech-oriented company. It should employ less than 10 people (but more than 2 full time equivalent staff) that has operated for less than three years and has attracted more than €50k early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% FTSP while other SMEs would receive 70% funding. Startups would be expected to highlight the impact that the project will have on their overall Company strategy and growth prospects in the Impact section of their proposals (as well as the impact on society and European competitiveness.*

available in the AI-on-Demand platform⁷⁸, Digital Industrial Platform for Robotics⁷⁹, data platforms⁸⁰ and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms in order to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice. This topic implements the co-programmed European Partnership on AI, Data and Robotics.

Tomorrow's deployable Robots: efficient, robust, safe, adaptive and trusted

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-11: Pushing the limit of robotics cognition (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Smarter robots with improved capabilities, functionalities (including complex functionalities such as manipulation of delicate, irregular, dynamic or deformable objects, navigation in un-controlled and variable or challenging environments) and increased level of autonomy, necessary to address real-world problems
- Smooth and trustworthy human-robot collaboration through advanced reactivity and mutual understanding.

New generation of AI-Powered Robotics: Enabling robots to have more profound impacts than they currently have, in powering them with a deeper kind of AI, endowing them with a better perception and understanding of the world (up to semantic and explainable representations), This would allow the next generation of autonomous robots, with increased capabilities to work without/with limited supervision, as well as the next generation of

⁷⁸ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁷⁹ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

⁸⁰ E.g.: <https://www.big-data-europe.eu/>

interactive robots, with greatly improved intuitive, safe and efficient cognitive, social and physical capabilities, to assist humans.

Scope:

- Develop enabling technologies, both new and existing, that extend the current state of the art in robotics perception, cognition, interaction and action as well as develop novel tools for the design and configuration of robots and robot systems that speed up the process of integration thereby reducing the time taken to deploy robot solutions. To do so by addressing the modularity and composability of solutions both in the operational context of a wide range of action and interaction use cases. There is also a need to address concepts such as trustworthiness, privacy, security and ethics already at the technology design phase.
- Develop lifelong autonomous robotics able to tackle unknown situations and adapt in the long term in pushing the state of the art of AI-based robots that combine monitoring, learning, planning and acting in order to evolve in difficult environments over long period of time.
- Increase robot acceptance by handling adequately both human and robotic actions, with human-centric, advanced behavioural and elaborated planning models, and adopting multidisciplinary approached including SSH, as well as end-user involvement in the design of solutions addressing human factors and interaction. Gender and intersectionality dimension analysis should be a part of the proposals, where relevant.
- Make robotics the interdisciplinary fulcrum of the Interaction Technologies i.e. of the methods and techniques that allow the machines to engage in a physical interaction with people or the environment, safely and intelligently, through specific enabling technologies: intuitiveness and responsive human-robot interfaces; integration of robot perception with natural and artificial intelligence; ability to physically, stably, dependably and safely interact with the environment, including users and surrounding people; development of advanced control tools for dexterous manipulation and locomotion in diverse environments (ground, air, water, space, in-vivo and including hazardous environments that are corrosive, explosive, nuclear or at extremes of pressure or temperature) and in general for improved performance of robots; energy autonomy and resilience to highly limited and imperfect communication networks in on-field applications.

Two types of proposals are expected, either focusing on higher level of autonomy, expecting less reliance on human supervision, or focusing on human-machine collaboration.

- The first type of proposals will build on the latest developments in areas such as advanced perception, smart sensors, intelligent action and interaction, reasoning and learning, increased interpretation and understanding of the complex real-world environments (possibly involving human actions), anticipation of the effect of actions, adaptation and re-planning, graceful degradation, safety and security, etc. They will, as

appropriate, further develop such components, and integrate them in an advanced robotics system, consider the balance of on-board vs off-board processes and the access and utilisation of external data and cloud resources to guide tasks and missions by adding external knowledge to internal reasoning and decision-making processes.

- The second type of proposals will further develop and integrate physical human-robot interaction as well as verbal/non-verbal communication, embedding safety, mutual understanding perception and interpretation of human actions, interaction situated in complex real-world environments and related motivations and social structures, joint goals, shared and sliding autonomy, ethical human-like behaviour by understanding of emotions, etc. to reach truly smooth human-robot collaboration. This should as well integrate advanced control developments, and further develop them as necessary to guarantee the necessary speed for the required reactivity, ensuring natural and smooth interactions with humans. Appropriate use should be made of data and knowledge accumulation from internal and external sources in order to guide reasoning and decision-making and the inclusion of explainability/transparency mechanisms⁸¹ appropriate to the use case. Such proposals should adopt a multidisciplinary approach and involve the necessary expertise in SSH, in particular in ethics and human-centric design to enhance trust and acceptability.

All proposals should also take into consideration trustworthy AI principles including respect of human dignity and agency.

In each case, improvement in the level of robotics cognition should be demonstrated through at least three real-world scenarios (including measurements of functional performance), showing also the potential added value of such improvement in the chosen use-cases. Scientific and technological progress should be demonstrated by qualitative and quantitative KPIs (including relevant service and production KPIs), demonstrators, benchmarking and progress monitoring. Activities are expected to achieve TRL 4-6 by the end of the project

All proposals should build on and reuse public results from relevant previous funded actions. Proposals should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform⁸², Digital Industrial Platform for Robotics⁸³, data platforms⁸⁴ and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms so as to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

⁸¹ Explainability mechanisms can use multiple communication modalities, verbal, non-verbal, gestural etc.

⁸² Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁸³ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

⁸⁴ E.g.: <https://www.big-data-europe.eu/>

HORIZON-CL4-2021-DIGITAL-EMERGING-01-12: Joining forces in scientific excellence in Robotics (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Scientific and technology advances in the major robotics challenges hampering its deployment
- A strong and tightly networked research community in robotics, making it a world-class powerhouse for robotics excellence.

Scope:

To ensure European strategic autonomy in robotics, with huge potential socio-economic impact, it is essential to reinforce and build on Europe's assets, including its world-class research community. In order to stay at the forefront of technological developments, it is essential that researchers collaborate, share ideas and research outcomes. A strongly networked community focused on excellence will be better at addressing the major robotics challenges that block the domain's further development and deployment.

As stated in the communication from the European Commission on Artificial Intelligence for Europe⁸⁵ and the coordinated action plan between the European Commission and the Member States and Associated Countries⁸⁶, while Europe has undeniable strengths with its many leading research centres, efforts are scattered. Therefore, joining forces will be crucial to international competitiveness. Europe must scale up existing research capacities and reach a critical mass through tighter networks of European robotics excellence centres. Proposals should develop mechanisms to reinforce and network excellence centres in AI-powered robotics, bringing the best scientists from academia and industry to join forces in addressing the major robotics challenges hampering its deployment, and to reinforce excellence in

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robotics throughout Europe via a network of collaboration that focuses research excellence on future industrial needs.

Such networks are expected to mobilise leading researchers to collaborate on key robotics topics, to reach critical mass and increase the impact of the funding in progressing faster in joined efforts rather than working in isolation, with fragmented and duplicated efforts.

Composition of the Network:

- It should be driven by leading figures in robotics from major excellent research centres, and industries, bringing the best scientists distributed all over Europe. They will bring on board the necessary level of expertise and variety of disciplines and profiles to achieve their objectives.
- Industrial participation will be ensured through inclusion of industrial organisations with research teams from multiple sectors that can bring into the network the expertise to identify important technological limitations hampering deployment in industry.
- Where relevant, representatives of civil society (e.g. social partners, citizen's committees) bring in the ideas and needs of consumers/users and society, in order to obtain R&I results that are of practical relevance not only for industry/business but also for society.
- It will include sustainable access to the required resources and infrastructure to support R&D, such as robotics equipment, support staff and engineers to develop experiments that address the major future robotics challenges.

Activities of the Networks:

- In order to structure the activities, the proposals will focus on important scientific or technological challenges with industrial relevance and where Europe will make a difference, either in building on strengths, or strengthening knowledge to fill gaps critical for Europe.
- Based on these challenges, the proposals will develop and implement common research agendas. The main vision and roadmap with targets within the projects, as well as methodology to implement and monitor progress will have to be specified in the proposal and can be further developed during the project.
- Progress will be demonstrated in the context of use-cases, also helping to foster industry-academia collaboration
- Strong links will be developed among the members of the network, notably through collaborative projects, exchange programmes, workshops, or other mechanisms to be defined by the consortia.
- Proposals should develop mechanisms to foster excellence, to increase efficiency of collaboration, and to develop a vibrant Robotics network across Europe.

- The network will disseminate the latest and most advanced knowledge to all the academic and industrial Robotics laboratories in Europe and involve them in collaborative projects/exchange programmes. (This could involve projects defined initially or via financial support to third parties, for maximum 20% of the requested EU contribution).
- The network will develop strong interactions with industry, and where relevant, with trade unions, and civil society (inside the consortium and beyond), in view of triggering new scientific questions and fostering take-up of scientific advances.
- The network will develop collaboration with relevant Digital innovation Hubs, to disseminate knowledge and tools, understand their needs, and extend the industry-academia-civil society collaboration.
- The network should also foster innovation and include mechanisms to exploit new ideas coming out of the network's work (for instance via incubators).
- Proposals should define mechanisms to become a virtual centre of excellence, offering access to knowledge and serve as a reference in robotics, including activities to ensure high visibility, usability and accessibility.

The proposals should

- Include mechanisms to spread the latest and most advanced knowledge to all the robotics-labs in Europe
- Develop synergies and cross-fertilization between industry, civil society, and academia
- Ensure that the network becomes a common resource and shared facility, as a virtual laboratory offering access to knowledge and expertise and a magnet for talents.
- Establish high visibility and accessibility, creating an easy entry point to robotics excellence in Europe where it is possible to access cutting edge ideas, research and expertise.

Proposals should define a number of major scientific and application challenges it will focus on and which will mobilise the community to join forces across Europe in addressing them. Continuous evaluation and demonstration of progress towards solving the targeted challenges will motivate the entire network and support publications and scientific career developments (providing references to publish comparative results, using the reference data, scenarios, etc.), and also showcase the technology in application contexts, to attract more user industries and eventually foster take-up and adoption of the technology. Scientific and technological progress will be monitored through qualitative and quantitative KPIs (including industry and service relevant KPIs), demonstrators, benchmarking and progress monitoring processes.

Activities are expected to achieve TRL 4-6 by the end of the project.

To address limitations of the use of robots due to human factors, an interdisciplinary approach involving both technical and SSH researchers is encouraged to address issues such as interaction design, human factors, acceptability, non-discrimination and biases and trustworthiness, taking into account gender and intersectionality aspects, as appropriate. Indeed, human-centred approaches in combination with multi-stakeholder co-design activities can contribute to sustainable development of new enabling technologies. Putting people at the forefront is expected to generate novel transformation pathways, which can remedy existing technology in novel ways, and propose feedback loop systems that engage human users in developing new sociotechnical learning situations and tools. Further, agile sociotechnical learning designs can remedy e.g. less efficient technologies, by emphasizing human aspects of technologies in any sector (industry, healthcare, smart homes, etc.). Where appropriate, special attention will be given to including users of diverse age, gender and background.

The proposals are expected to include mechanisms to share resources, knowledge, tools, modules, software, results, expertise, and make equipment/infrastructure available to scientists to optimise the scientific and technological progress. To that end, tools such as the AI-on-demand platform⁸⁷ and Digital Industrial Platform for Robotics⁸⁸ should also be exploited, enhanced and further developed by the network, to support the networking, quality assessment, benchmarking and sharing of resources, maximising re-use and up-take of results.

The proposals are also expected to include collaboration mechanisms among the best robotics teams, but also mechanisms to bring all European robotics teams to the highest level of excellence.

Proposals are expected to develop synergies with relevant activities in AI, Data and robotics, primarily in destination 3, 4 and 6, but also in other destinations and clusters, and share or exploit results where appropriate.

European leadership in Emerging Enabling Technologies

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-13: Academia-Industry Forum on Emerging Enabling Technologies (CSA)

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

⁸⁷ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁸⁸ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- European thought leadership in academia and industry on future enabling technologies and their transformational potential in industrial, societal and environmental terms.
- Increased engagement for structural collaboration and co-creation between academic, industry players and other stakeholders where roles of research, industry and society intertwine in an iterative and multidisciplinary approach for co-creating the enabling technologies of the future, all the way from low to higher TRLs, such as (but not limited to) bio-enabled technologies, sustainable smart materials and alternative computing models.
- Alignment with national or regional initiatives creating an expanding innovation ecosystem, anchored in local contexts across Europe, for selected emerging technologies.
- Accelerating the pick-up of novel advanced technology by industry and society.

Scope: A Coordination and Support Action to create and catalyse a forum for emerging interdisciplinary areas and new technological visions. These actions enable and support a broad range of participants (across research disciplines, industry sectors, stakeholders) to meet, mutually inspire, cooperate and develop together innovative ideas for future enabling technologies. They will help industry to navigate rapidly changing environments, for instance by actively transferring ideas and early technologies between players that would not normally interact, or by combinations of different foresight activities (short-term, long-term, cross-sectorial) to prioritise strategic directions while avoiding narrow visions for the future.

Concrete activities will include horizon scanning, portfolio analysis, a variety of participatory workshops, visibility in various meetings, high-profile reporting on emerging enabling technologies. This will build on (and link to) existing programmes and research portfolios from European and Member States' programmes (including at low TRL) as well as broad sourcing from foresight and technology scouting activities, including those specifically done by this action for the cluster 4 industries and sectors. The forum should link to existing initiatives and partnerships and add value by active cross-fertilisation across disciplines and sectors, and by breaking the model of linear progression of technology development. National or regional R&I priorities and orientations from European countries shall be taken into consideration. Broader stakeholder engagement is expected.

The forum should become a reference for new enabling technologies at different levels of maturity, their purpose, their transformational pathways and their impacts with a distinctive anchoring in European industry and research, as well as providing guidance and reasoned

alternatives for Europe's transformations, in line with the Commission priorities (in particular, Green Deal, Digitisation, and Industrial Strategy).

Proposals should involve and be driven by representatives of the relevant actors of the field (e.g., academia, RTOs, industry including SMEs).

**HORIZON-CL4-2021-DIGITAL-EMERGING-01-14: Advanced spintronics:
Unleashing spin in the next generation ICs (RIA)**

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Disruptive spin-based hardware components and devices, with significant progress towards the wafer-scale integration to provide industry compatible solutions for memory, sensing, imaging, communication and computation.
- First spin-based digital devices (Spin-chips) that exhibit significant decrease in energy consumption.
- Large-scale complete systems that include next generation spintronics devices with emphasis on compatibility, integration of different materials & technologies including CMOS and photonics.

Scope: Proposals should focus on interdisciplinary R&D between academic research, RTOs and industry (including SMEs) in order to address at least one of the following medium term challenges in spintronic components and devices:

- Develop new classes of materials (such as two-dimensional magnetic materials and heterostructures with tailored magnetic ordering, sensitive to different stimuli, e.g., light, electric field, stress etc.), achieving experimentally the largest effects allowed by physics to create new components and devices, including non-conventional ones, beyond the state of the art.
- Boost utilization of Spin-Charge interconversion for detecting spin currents or manipulating the magnetization of ferromagnets: this is key for ultra-low power

operations as well as for a change of paradigm in logic with the goal of cutting down the energy consumption by a factor of 1000, enabling ultra-low energy, autonomous and safe devices towards attojoule electronics.

- Reach a massive gain in energy and time scales by profiting from collective spin excitations (spin waves) and their interaction with other waves/quanta carrying angular momentum (e.g., phonons, photons, plasmons or heat waves) for ultra-fast logic and data transfer.
- Master magnetic noise, stochasticity and chaotic behavior for improved sensitivity, room temperature operation, and development of new device functionalities that enable new architectures and algorithms for use in a variety of sectors.

Proposals should aim at demonstrating a fully functional prototype of a spintronic device operating in relevant environment conditions (TRL 4-5) in order to show how it will unlock the full potential of the field in a number of specific and high potential application areas.

The proposals that will be funded under this topic are expected to collaborate in order to create a critical mass of cooperation between EU research, industry and other relevant actors in the area of spintronics. The overall goals are to put this emerging technological paradigm firmly on the industries' roadmaps, to foster the interdisciplinary communities that are driving this forward and to improve the visibility for all key stakeholders.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-27: Development of technologies/devices for bio-intelligent manufacturing (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome: The use of biological elements as key enabling technology for manufacturing is an emerging trend that perfectly concurs with the pressing requirements of sustainability.

Biological transformation of industry can harness innovative and more efficient modes of production which can satisfy the needs of future generations.

Projects are expected to contribute to the following outcomes:

- Strengthening European leadership in bio-intelligent manufacturing to support the industrial biological transformation;
- Developing of key enabling technologies which use biological components (and data) with an interface to a technical system making decisions, or a biological system with intrinsic intelligence for technical applications in manufacturing – in best case with a bi-directional communication between the biological and the technical system;
- Mainstreaming the integration of biological principles, functions and structures with other technologies – including digital – leading to novel, more efficient, manufacturing processes and methods;
- Facilitating extensive interdisciplinary collaborations and knowledge transfer among different disciplines such as bio engineering, biology, industrial manufacturing and Social Science and Humanities.

Scope: In a context of increasing constraints in the usage and production of resources, bio-intelligent technologies should arise as key enabling manufacturing systems under any circumstances while fostering the biological transformation of industry. In this sense, research activities should be highly multi-disciplinary and networked to the strengthening of European industrial leadership and autonomy in this emerging technology.

Proposals should investigate the potential of bioenabled technologies through the integration of biological principles with other technologies, to bolster future supply chains and more efficient manufacturing.

Proposals should aid the biological transformation of industries, investigating the biological-technical interfaces of industrial and technological applications.

Research activities under this topic should cover (but not be limited to):

- Biomimicry of biological mechanisms to enable discrete manufacturing;
- Development of bioinspired systems and materials with technological and data interactions;
- Exploring potential synergies between nano- and biotechnology in production technologies;
- Biosensors and bioactuators as enablers of novel manufacturing techniques, building on bi-directional communication between a biological and technical systems to aid discrete manufacturing;
- The use of biological components to increase efficiency in controlled manufacturing processes.

Proposals should investigate the use of Big Data as a key enabler of the bio-technological transformation in manufacturing.

Proposals should explore the use of data processing, Digital Twins and AI integrating data exchanging between biological systems to technical components for the discrete manufacturing environment.

Research activities should also cover societal and business challenges associated with biointelligent manufacturing.

Flagship on Quantum Technologies: a Paradigm Shift

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-01-15: Framework Partnership Agreement for developing the first large-scale quantum computers (FPA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	HORIZON Framework Partnerships
<i>Funding rate</i>	na%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum computing is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Expected Outcome: Framework Partnership Agreements (FPAs) in quantum computing are expected to establish a stable and structured partnership between the EC and the institutions and organisations in quantum computing who commit themselves to establishing, maintaining and implementing a strategic research roadmap aligned with and contributing to the Quantum Flagship Strategic Research Agenda in a scalable open quantum computing platform based on a specific quantum platform technology.

These partnerships will be set up through two FPAs, which will enable the completion of the research roadmap within the context of the agreement.

The consortia responding to the call may include research institutes, universities, RTOs, foundations, industry, SMEs as well as other organisations that can play a role in the realisation of these quantum computing platforms. The FPA shall specify the objectives, the nature of the actions planned, and the procedure for awarding specific grants. Each FPA is expected to contribute to the following outcomes:

- Demonstrate a universally programmable processor of at least 100 physical qubits (by 2025) operating in the NISQ⁸⁹ domain including firmware and having sufficient coherence to perform computations involving all of its qubits; characterise with a hardware-agnostic test suite, including real-world applications and the capability of outperforming classical computers on a number of relevant real-world use-cases; control needs to involve a low-level control system, a compiler and a scheduler.
- By 2029, build a full stack, highly connected, high fidelity quantum computer of at least one thousand physical qubits, exhibiting scalable performance and capable of outperforming classical computers on relevant real-world use-cases.
- Formulate standards and interface specifications for a complete software and hardware stack.

Scope: Fostering a vibrant European quantum computing industry will require hardware, software, and the development of user interfaces. Proposals for FPAs are expected to build on the quantum computing platforms supported under the Quantum Flagship ramp up phase. Proposals should target the development of open quantum computing platforms, integrating the key building blocks such as quantum processors in the NISQ regime (>100 qubits) with limited qubit overhead, control electronics, low-level software, verification and validation of the quantum computation, etc.

Proposals should include practical strategies towards the break-even point of fault tolerance to increase algorithmic depth (number of operations) for quantum computing on existing platforms.

Proposals for FPAs must describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific leadership.

Proposals for FPAs should also address how to integrate in these platforms a full software stack, including a compiler and scheduler, programming tools, a suite of algorithms, etc., that would allow them to showcase their capability of solving real and concrete computational problem(s) that demonstrate a quantum advantage.

Proposals should aim at the development of open quantum computer experimental systems, and work on the reduction of their form factor.

⁸⁹ Noisy intermediate scale quantum

Proposals for FPAs should also cover: (i) the cooperation with complementary projects launched specifically in the area of the enabling quantum software stack (see topic 4 below), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements; (ii) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (iii) any additional support they may receive in their activities from relevant national, or regional programmes and initiatives; and (iv) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-17: Framework Partnership Agreement for developing large scale quantum simulation platform technologies (FPA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	HORIZON Framework Partnerships
<i>Funding rate</i>	na%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum simulation is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Expected Outcome: Framework Partnership Agreements (FPAs) in quantum simulation are expected to establish a stable and structured partnership between the EC and the institutions and organisations in quantum simulation who commit themselves to establish, maintain and implement a strategic research roadmap in a scalable open quantum simulation platform based on a specific quantum simulation platform technology.

These partnerships will be set up through an FPA, which will enable the completion of the research roadmap within the context of the agreement.

The consortia responding to the call may include research institutes, universities, RTOs, foundations, industry, SMEs as well as other organisations that can play a role in the realisation of these quantum computing platforms. The FPA shall specify the objectives, the

nature of the actions planned, and the procedure for awarding specific grants. Each FPA is expected to contribute to the following outcomes:

- Fully programmable open quantum simulators reaching several hundred individual quantum constituents (by 2025/2026) and above 1000 quantum constituents (by 2029).
- Improved levels of control and scalability and achievement of a further entropy reduction (by a factor of 2 in 2-3 years) of quantum simulators.
- Demonstrated full quantum simulation stack and operational stability for various classes of problems by ensuring maximum online availability.
- Wide accessibility to the quantum simulation platform facilities capable of outperforming the best supercomputers in physical simulations and in a large number of hard optimisation problems relevant for real-world use-cases.

Scope: Proposals for FPAs should aim to build quantum simulators that are capable of simulating far beyond classical possibilities for hard-to-compute quantum or classical systems. The resulting simulator should be based on and reinforce existing physical platforms (such as ultra-cold atoms, trapped ions, Rydberg atoms, photonics or other qubits), therefore consolidating the European scientific leadership in this field. The simulator platform should include user-interfaces and software to allow applications of real world problems in e.g. material science, quantum chemistry and others.

Proposals for FPAs should expand and strengthen the supply chain, aiming for the development of key enabling technologies while improving notions of control of quantum simulators. Entropy reduction and interaction engineering should be supported throughout.

Proposals for FPAs are expected to take in perspective the learning properties of physical systems or to make use of programmable quantum simulators to solve near-term problems of end-users. Applications should be identified in solving practical routing and scheduling problems, and in offering cloud services in the quantum simulation of strongly correlated quantum systems and materials. Proposals should also develop a comprehensive and strategic patent portfolio to protect innovations in the field of quantum simulation and to provide information about the IPRs that are open to licensing.

Proposals for FPAs should also cover: (i) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (ii) any additional support they may receive in their activities from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-19: Framework Partnership Agreements in Quantum Communications (FPA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	HORIZON Framework Partnerships
<i>Funding rate</i>	na%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum communication is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Expected Outcome: Framework Partnership Agreements (FPAs) in Quantum Communication Technologies are expected to establish stable and structured partnerships between the EC and the institutions and organisations who commit themselves to establish, maintain and implement a strategic research roadmap in Quantum Communication Technologies.

These partnerships will be set up through two FPAs, which will enable the completion of the research roadmap within the context of the agreements.

The consortia responding to the call may include research institutes, universities, RTOs, foundations, industry, SMEs as well as other organisations that can play a role in the realisation of Quantum Communication Technologies. The FPAs shall specify the objectives, the nature of the actions planned, and the procedure for awarding specific grants.

The first FPA (on “building the Quantum Internet”) is expected to contribute to the following outcomes:

- Demonstrate long-distance (i.e., above 500 km) entanglement distribution involving quantum memories, and demonstrate a fully functional prototype of a quantum repeater operating across multiple nodes of a real world communication network that will unlock the full potential of a global quantum internet interconnecting quantum computers, simulators and sensors via quantum networks;

- Demonstrate a scalable interface connecting quantum computers via a quantum network spanning multiple cities in order to enable advanced use cases of a quantum internet.
- Demonstrate a platform-independent software and network stack on a quantum communication/information network consisting of at least two quantum computing nodes with quantum memories. The network should demonstrate resistance to known forms of attack.

The second FPA (on “quantum encryption and future quantum network technologies”) is expected to contribute to the following outcomes:

- Demonstrate open, large-scale, quantum communication networks and system architectures, based on cost-effective network devices and equipment necessary to distribute classical secret keys or quantum information transport over direct communication links as well as, across multi-node quantum networks, demonstrating secure communication over long distances as well as its integration with classical networks; and, support the development of applications over such networks relevant for the EuroQCI initiative, such as authentication, long-term secure storage, primitives for multi-party computation between untrusted players, and clock synchronisation.
- Demonstrate future quantum network technologies in support of the EuroQCI initiative, and showcase disruptive progress in the performance, reliability and efficiency of relevant digital components and devices.

Scope: Proposals for FPAs are expected to develop quantum communication technologies with improved performance and security to ensure European leadership. They are expected to build on the ongoing projects supported under the Quantum Flagship ramp up phase and on those currently defining the EuroQCI initiative.

Their focus should lie mainly in realising a quantum communication/information network, over very large distances, well beyond what is currently possible, and enabling advanced application functionality for distributing resources such as entanglement. This includes the development of quantum memories and quantum repeaters that are the building blocks of long-distance quantum communication networks on the ground, and could be deployed in a European quantum communication infrastructure (EuroQCI).

Proposals for the first FPA (on “building the Quantum Internet”) should focus on the development of a quantum internet interconnecting quantum computers, simulators and sensors via quantum networks. These quantum networks should allow long-distance (>500 kilometres) entanglement-based quantum communication involving quantum memories, and will be inter-linked via a fully functional prototype of quantum repeaters. The FPA proposal should also address the proper functioning of a platform-independent software and network stack for managing and programming the quantum communication network consisting of at least two quantum computing nodes with quantum memories.

Proposals for the second FPA (on “quantum encryption and future quantum network technologies”) should focus on the development of (i) a robust, non-dependent and sustainable supply chain of future-proof Quantum Key Distribution (QKD) technologies; (ii) integration and interoperability in cybersecurity systems and classical communication networks based on optical fibre networks; and (iii) the development of the next generation of quantum communication systems (e.g., device-independent, twin field QKD) with improved performance and security protocols, and increased deployability through miniaturisation, compared to the first generation of QKD systems. Proposals should advance quantum network technologies in the above mentioned areas with the aim to achieve improved performances (e.g., higher key rates, fidelities, link distances, robustness, ...), post-processing of key generation, key management, including interface to security applications (point-to-point link), achieving higher level system integration and robustness, combining quantum network technologies with conventional network infrastructures (including infrastructures based on post-quantum cryptographic technologies) and applications for point-to-multipoint links, including new protocols, applications and software and interface management between space and ground infrastructures.

Proposals for FPAs should also cover: (i) the cooperation with complementary projects launched specifically in the area of quantum encryption and future quantum network technologies (see topic 2), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements, (ii) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (iii) any additional support they may receive in their activities from relevant national, or regional programmes and initiatives; and (iv) contribution to the governance and overall coordination of the Quantum Technologies Flagship and (wherever relevant) EuroQCI. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-20: Quantum sensing technologies for market uptake (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%
<i>Eligibility</i>	The conditions are described in General Annex B. The following

<i>conditions</i>	exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.
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Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- A host of mature quantum sensing technologies and devices (TRL 6-7) in many different application sectors, with the goal of establishing a reliable, efficient supply chain including first standardisation and calibration efforts for rapid market uptake.

Scope: Proposals should address the development of relatively mature quantum sensing technologies and single or network-operating devices that have the potential to find a broad range of new applications in transportation, precise localisation, health, security, telecommunications, energy, electronics industry, construction, mining, prospection, and much more.

Proposals should demonstrate advanced prototypes of such sensing technologies that provide an unprecedented level of precision and stability, making new types of sensing, imaging and analysis possible. For rapid market uptake, they should target miniaturised, integrated, transportable quantum sensors and provide first plans for their further industrialisation through enhanced cost efficiency and user operability at higher TRL.

In order to achieve the above, proposals should include relevant actors from the whole value chain (from materials to devices and to system integration aspects). They may also include, wherever relevant, activities and actors from metrology institutes that would provide measurement methods and/or standards, including for the development of quality assurance methods and for standardisation of the targeted quantum sensing technologies.

Finally, proposals should also cover: (i) any additional support they may receive from relevant national, or regional programmes and initiatives; and (ii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-21: Next generation quantum sensing technologies (RIA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p>

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

- Demonstrate the feasibility of next generation quantum sensing technologies and devices by showing disruptive progress in the performance, reliability and efficiency of such technologies and devices and by enhancing the TRL of all (essential) components necessary to build them.

Scope: Proposals should focus on next generation quantum sensors that provide extreme precision and accuracy measurements in many fields, boosting the performance of consumer devices and services, from medical diagnostics and imaging, high-precision navigation, and monitoring, to future applications in the Internet of Things and for enhanced measurement and metrology.

Proposals should address: (i) the development of new methods and techniques to achieve full control over all relevant quantum degrees of freedom and to protect them from environmental noise; and/or (ii) identify correlated quantum states that outperform uncorrelated systems in a noisy environment and methods to prepare them reliably. Proposed work should exploit quantum properties (such as coherence, superposition and entanglement) emerging in quantum systems to improve the performance of the targeted sensors technologies (e.g. in terms of resolution, sensitivity or noise), well beyond the classical limits.

Proposals should target the development of laboratory prototypes (from TRL 2-3 to 4-5) demonstrating the practical usefulness of engineered quantum states of light/matter to improve sensing or imaging and develop and demonstrate optimized quantum software for detection applications in real-world applications. They should leverage interdisciplinary expertise and join forces with metrology institutes or other relevant technical fields to further advance the limits of sensors sensitivity and resolution and to implement the best control protocols, statistical techniques (e.g. Bayesian, among others) and machine learning algorithms.

Finally, proposals should also coordinate their respective activities within each sensing subfield (solid-state, atomic systems, photonics) and contribute to the governance and overall coordination of the Quantum Technologies Flagship. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	HORIZON Framework Partnerships
<i>Funding rate</i>	na%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum technologies are an emerging field of global strategic importance. Other major players are investing heavily in them, and they have extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

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

Framework Partnership Agreements (FPAs) respectively for open testing, experimentation, and for pilot production capabilities for quantum technologies are expected to establish stable

and structured partnerships between the EC and the institutions and organisations who commit themselves:

- To create long-term open, supportive and sustainable experimental and testing infrastructures in Europe that are openly accessible by European academia and industry; and,
- To develop and provide access to first European fabrication (production) capabilities for quantum technologies, building on and linking together existing infrastructures.

These partnerships will be set up through two FPAs, which will enable the completion of the research roadmap within the context of the agreements. The FPAs shall specify the objectives, the nature of the actions planned, and the procedure for awarding specific grants.

The first FPA (“supporting open testing, and experimentation for quantum technologies in Europe”) is expected to contribute to the following outcomes:

- Establish a technology innovation roadmap through effective consultation with industry for linking early-stage capabilities to industry developments.
- Provide open testing, and experimentation capabilities for quantum technologies, that are available to scientists, engineers and users, and provide innovation support services to individual companies, in particular a broad spectrum of SMEs.
- Establish a well-connected network at European level and federate competences to increase European testing and experimentation capabilities of quantum technologies, and reduce their time-to-market.
- Provide services for the development of a European supply chain of quantum technologies, provide European industry, especially start-ups and SMEs, with the necessary innovation capacity, and make sure that critical IP remains within the EU.

The second FPA (“supporting experimental production capabilities for quantum technologies in Europe”) is expected to contribute to the following outcomes:

- Establish a capability innovation roadmap for providing experimental (pilot) production capabilities and a roadmap for transferring such capabilities to an industrial production environment.
- Provide experimental production capabilities for quantum technologies in computing, communication and /or sensing available to users, including industry, in particular SMEs and contribute to developing European standards in the field.
- Provide services for the development of a European supply chain of quantum technologies, provide European industry, especially start-ups and SMEs, with the necessary innovation capacity, and make sure that critical IP remains within the EU.

Scope: Proposals for both FPAs above are expected to establish well-networked lab facilities that interact and support each other. Proposals should federate key competences in the whole innovation value chain, from business-model development to promoting open-access to innovation and know-how, in order to provide access and support to European quantum technologies innovation actors.

Proposals should develop practical strategies in synergy with European academic and industrial players (especially start-ups and SMEs), and quantum technologies innovation actors in Europe to provide the quantum ecosystem with a ‘one-stop-shop’ to unique facilities, competences and know-how centred at various locations in Europe.

The consortia applying for the first FPA should include a balanced and inclusive network of RTOs and other excellent European institutes equipped with state of the art quantum experimental facilities, infrastructures and tools, and other key innovation players that can play a role in the implementation of sustainable open experimental and testing infrastructures in quantum technologies.

The consortia applying for the second FPA should include a balanced and inclusive network of RTOs and other excellent European institutes, small foundries, unique manufacturing providers, and other key innovation players that can play a role in building and providing experimental pilot production capabilities for quantum technologies.

The proposal for both FPAs should also cover: (i) the collaboration with other initiatives or programmes at regional, national, or European level; (ii) the any additional financial support they may receive in their activities from relevant national or regional initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-23: International cooperation with Canada (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome: Joint EU – Canada projects are expected to contribute to the following outcomes:

- Advances in quantum technologies in specific areas of mutual EU – Canada interest, including quantum computing and simulation, quantum networking and communication, quantum sensing and metrology.
- Reinforcement of EU – Canada research excellence in the specific areas of mutual interest described above, including the establishment of strategic partnerships in research, education and training.

Scope: Proposals are expected to address a mix of quantum technology challenges in the areas of quantum communication, computing, simulation and sensing and identify the added value and/or mutual benefit for both EU and Canadian partners. These should include the integration of different aspects like physics, engineering, computer science, theory, algorithms, software, manufacturing, control, infrastructures, etc.

Relevant technological and societal challenges to address, include:

- Quantum computing and simulation co-design of hardware and software to accelerate applications; seamless interoperable software-to-hardware stack that can apply over multiple platforms, and theoretical and computer science foundations of quantum algorithms and architectures.
- Privacy and security concepts, proofs and applications for quantum communication, including QKD (quantum key distribution) and beyond; device independent protocols, quantum network/repeater protocols, including architectures and network stack; development of satellite and space-based hardware, and certification/verification of states and correlations.
- Application-specific quantum sensor development covering: device fabrication, characterisation, e.g. for magnetometry, prospection, imaging, navigation, biomedical, and theoretical research optimising simple sensors, control, as well as advanced approaches (use of entanglement and error correction).

Proposals should address one or more of the above technological and societal challenges and clearly define the benefit the EU-Canada collaboration brings. In order to raise the Technology Readiness Level (TRL), support for holistic - software and hardware - engineering approaches across all areas are encouraged in consortia involving participation of relevant public and/or private partners.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-24: Standardisation support in quantum technologies (CSA)

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

	different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- contribute to the development of international standards and regulations in quantum technologies and quantum applications, ensuring that Europe plays a leading role in global quantum standardisation initiatives.

Scope: Proposals should address concrete standardisation activities in European and international standardisation fora where quantum technologies will play a major role in the near future and where standardisation can enhance existing capabilities and offer a competitive advantage to Europe. Examples are: quantum computing and quantum-enabled security such as QKD, QRNG, quantum sensing and metrology, including quantum enhanced medical imaging devices, quantum gravity sensing devices, quantum timing devices, etc.

For this, proposals should develop an active presence and leadership in the coordination and development of international standards and regulations in quantum technologies either in existing standardisation activities and bodies and where relevant, by contributing to creating new standardisation activities in existing groups and/or creation of new groups.

Proposals should bring together all the relevant stakeholders in the whole quantum technology standardisation value chain – research, standardisation and the industry sectors, and if relevant, public administrations/institutions. They should describe which players they will mobilise and how they will efficiently coordinate them at European level to achieve impactful results promoting the European interests in standardisation. Links to metrology aspects should also be included, wherever relevant. Proposals should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-25: Support the coordination of the Quantum Technologies Flagship activities (CSA)

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

<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- support the efficient functioning of the Flagship and promote its activities to a wide public
- enable Flagship projects to find synergies in their work and share best practice
- publish a European research and industry community roadmap that provide the route from research to industrial exploitation
- foster a European quantum community and provide a forum for productive discussions on Research and Innovation strategies.

Scope: Proposals should ensure the smooth running and further development of the Flagship and raise the profile of its activities and of quantum technologies in general and update the European Strategic Research and Innovation Agenda, in particular by working on the following: support the operation of the Flagship's governance structure; conduct a community based process for preparing a Research and Innovation investment Roadmap and priorities by involving research and industry stakeholders, undertake wide dissemination of the Quantum Flagship results; organise outreach events and engage in structured discussions with the general public, including on the social implications and ethics of quantum technology development and innovation, particularly with regard to privacy and security, public trust and acceptance; provide research dissemination services to projects; identify relevant training, education and infrastructure needs.

This structured dialogue with the general public will take the form of engagement via all meaningful platforms including social media, and the results may be compared with those of international cooperation partners of the Flagship (e.g. Canada), and shared on the basis of mutual exchange. Proposals should also encourage the Flagship's projects to find synergies in their activities and share best practice, and foster the growth of a European quantum community that links all academic and industry stakeholders, including by contributing to the coordination of activities between European, national and regional programmes and projects.

Finally, proposals should work on establishing dialogue with other international programmes in quantum technologies and in promoting international cooperation activities. In particular, they should be supporting collaborative discussions between the main international players, including countries such as the USA, Canada, Japan, Australia, and the EU, exploiting complementary strengths and challenges in collaborative research that ensures a clear win-win situation for both parties and ongoing leadership on the global stage.

Proposals should involve and be driven by representatives of the relevant actors of the field (e.g., academia, RTOs, and industry, including SMEs, and intermediaries). They should also

contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-30: Investing in new emerging quantum computing technologies (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum computing is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Expected Outcome: Projects are expected to contribute by investing in a few other emerging and potentially promising quantum technology platforms besides the ones supported in the ramp-up phase of the Quantum Technologies Flagship, such as for example photonic qubits and neutral atom qubits such as Rydberg atoms, which would make it possible to complement those already funded in the Quantum Technologies flagship and which have the prospects of high scalability and fault tolerance.

Scope: In order to reach large-scale quantum computing in Europe, breakthroughs in scalability of quantum computing processors, devices and integrated platforms are needed, together with the ability to perform qubit operations such as read, write, and data transfer, and qubit manipulation with a universal set of quantum gates. Besides the traditional quantum architectures now under development in the Quantum Technologies Flagship, further qubit and platform types, such as for example neutral Rydberg atoms and photonic qubits, need to be considered as candidates for quantum computing that would require further research and development efforts.

The development of new emerging open quantum computer systems and platforms should be integrating the key building blocks such as quantum processors (> 10 qubits) with limited qubit overhead, control electronics, software stack, algorithms, applications, etc. Work should

address the scalability towards large systems (>100 qubits), the verification and validation of the quantum computation, fault-tolerance and solving a concrete computational problem to demonstrate the quantum advantage.

Proposals should also cover: (i) the cooperation with complementary projects launched specifically in the area of the enabling quantum software stack (see topic 4 below), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements; (ii) any additional support they may receive from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

Call - Digital and emerging technologies for competitiveness and fit for the green deal

HORIZON-CL4-DIGITAL-EMERGING-2022-01

Conditions for the Call

Indicative budget(s)⁹⁰

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ⁹¹	Number of projects expected to be funded
HORIZON-CL4-2022-DIGITAL-EMERGING-01-03	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-05	IA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-06	RIA	Around N/A	Not relevant	

⁹⁰ 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 2021 and 2022.

⁹¹ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2022-DIGITAL-EMERGING-01-07	IA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-09	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-10	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-11	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-12	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-13	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-14	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-15	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-16	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-17	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-18	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-19	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-22	CSA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-25	CSA	Around N/A	Not relevant	
HORIZON-CL4-2022-DIGITAL-EMERGING-01-35	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

European Innovation Leadership in Photonics

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-03: Sensor-based systems for biomedical, environmental and other advanced applications (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Next generation multi-sensing systems for multiple applications, including real-time environmental monitoring and protection, automated driving (e.g. LIDAR), advanced manufacturing and improved biophotonics device capabilities.

- Sensing devices allowing for reaching the new green deal objectives through enabling high levels of reuse/repair/repurpose, recovery and recycling of waste and materials or helping to reduce overall power consumption of a system by at least a factor of 2.
- High performance sensing technologies, combining sensor development, system integration, packaging and cost-effective manufacturing processes to support advances in data analysis, AI or IoT.

Scope: Enabling massively parallel multi-parameter/multi-analyte sensor systems for biomedical, environmental and other advanced applications, capable of acquiring, processing and interpreting vast amounts of sensory input data simultaneously, while reducing the data volume communicated to the outside world and hence overall energy consumption. Whenever justified, a modular approach with interchangeable components operating in a platform environment should be favoured.

Innovation in AI, data and robotics

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-05: AI, data and robotics for Industry optimisation (including production and services) (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

Expected Outcome:

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

- Advancing AI, data and robotics for the optimisation of production and services value-chains, optimisation of products, services, processes, to increase competitiveness, working conditions, and environmental sustainability, and supporting the European Economy using AI, data and robotics technologies.
- Learning systems (self-learning, continuous and transfer learning, autoML)/AI adapting production or services workflows to changing environments, dynamic and unpredictable resource constraints and to the capabilities and restrictions of humans and transferring results from one domain to another.

Scope: Industry-empowering AI, data and robotics: enable and boost wide spread deployment of European technologies, in demonstrating clear benefits in particular applications coming from major industrial sectors, in improving processes, products or services, contributing to their competitiveness, quality of services, and strategy for environmental sustainability. Providing industry with more autonomous and more intuitive and easier to operate technologies they can trust and that are tailored for their needs, with the adapted and guaranteed levels of performance, reliability, safety, dependability, security and transparency. Providing trustworthy AI solutions combining various sources of data, sensors, interaction and information to address industrial challenges; combining the power of latest progress in AI, FAIR⁹² data, autonomous or interactive robotics, smart devices and next generation networks and computing to increase automation and optimise processes, resources, and services, and addressing new scientific challenges removing barriers for industrial deployment, and improving trust through more transparent and explainable AI. Where relevant latest development from low power consuming sensors, actuators and mechanisms, as well as new energy sources and batteries will be exploited to ensure energy autonomy for robotics. Promoting versatile, flexible, scalable, resilient physical and digital architecture that facilitate the future AI, data and robotics based services adoption.

Proposals should demonstrate how major European industries (covering all the sectors, from production⁹³ to services) can substantially benefit from optimising AI, data and/or robotics to maximise such benefits. Added value to the selected use-cases should be demonstrated by qualitative and quantitative industry and service relevant KPIs, demonstrators, benchmarking and progress monitoring.

While the proposals should be application driven, involving problem owners to define needs and validate the proposed solution, the focus is on optimising enabling AI, data and robotics technologies to maximise the benefit they bring.

Proposals should focus on demonstrating the added value of AI and/or Data and/or Robotics technologies to optimise value-chains, products, services or associated processes, including knowledge automation, to increase competitiveness, environmental sustainability, and where relevant, working conditions, for example, through added flexibility, configurability, adaptability, etc.

Digital twin approaches could be considered, where necessary and of added value.

Proposals should also address non-technical issues hampering the adoption of AI, data and robotics in the selected application domain, e.g. ethical aspects for the possible replacement of human operators, trust, human-robots collaboration and cooperation, security and safety.

Proposals will address the production or service sector, where substantial added value of AI, data and/or robotics can be demonstrated. This should be demonstrated with real or close to real demonstrators at TRL6 or above.

⁹² FAIR data are data which meet principles of findability, accessibility, interoperability, and reusability

⁹³ Note that manufacturing industry will be excluded, as this topic is already covered in other topics.

Proposal should clearly identify the sector it will focus on (either production or services). To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but at least 2 highest ranked for each sector, provided that the applications attain all thresholds.

Two types of proposals are expected:

1. Focused projects involving the user industry and technology provider(s),
2. Larger projects where a number of organisations/companies in a given application sector will identify in the proposal common challenges and use-cases, and organise competitive calls for AI, data and robotics solution providers to address such challenges. Competitive calls will be open to any kind of companies, but SMEs and Start-ups⁹⁴ will receive financial support via FSTP, with a maximum of 200k€ per third party and 70% funding (100% for start-ups). At least 40% of the funding should be dedicated to FSTP funding. The consortium will provide technical support with expertise in engineering integration, testing and validation to support the selected SMEs and start-ups acting as technology providers to demonstrate the added value of their solutions to address the challenges of the use-cases.

In all proposals user industries are expected to play a major role in the requirement and validation phases.

Besides financial support, these SMEs and start-ups successfully demonstrating the potential of their solutions, will receive support from business experts to further develop their business and develop their market reach, and maximise their business opportunities.

All projects should build on and reuse public results from relevant previous funded actions. Projects should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform⁹⁵, Digital Industrial Platform for Robotics⁹⁶, data platforms⁹⁷ and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms so as to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice.

Where appropriate, issues such as data access, data sovereignty and data protection should be addressed along the whole value chains, respecting all stakeholder interests, particularly SMEs.

⁹⁴ *In this context a start-up is a tech-oriented company. It should employ less than 10 people (but more than 2 full time equivalent staff) that has operated for less than three years and has attracted more than €50k early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% FTSP while other SMEs would receive 70% funding. Startups would be expected to highlight the impact that the project will have on their overall Company strategy and growth prospects in the Impact section of their proposals (as well as the impact on society and European competitiveness.*

⁹⁵ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁹⁶ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

⁹⁷ E.g.: <https://www.big-data-europe.eu/>

The re-use and sharing of data collected and processed for AI and Data innovation should be encouraged to contribute to SDG and the Green Deal (sharing private data for the public good, B2G and not only B2B).

Proposal should include dissemination activities to increase awareness about the potential value for society and people as well as the business of AI, data and robotics driven innovation.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

Tomorrow's deployable Robots: efficient, robust, safe, adaptive and trusted

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-06: Pushing the limit of physical intelligence and performance (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Robots with advanced physical functionalities, capabilities and efficiency (faster, safer, more agile and precise, etc.), to achieve wider variety of tasks efficiently. This includes beyond human capabilities (e.g. very large and very small scale capabilities or beyond human precision, or beyond human perception and decision making using multi-modal sensors).
- Robots with greatly improved intrinsically safe and efficient human-robot physical interaction capabilities, at natural human speed or more.
- Robots with improved abilities and robustness, allowing them to adapt to changes in the environment, and making them more energy efficient in order to run autonomously for longer periods of time while maintaining trustworthiness and dependability.

Scope:

Improve the physical performance of robots (for example: improving robustness and resilience – to handle environment variations and unknown or unexpected situations - and energy efficiency to run safely and autonomously for longer period of time, increased speed, some operating under extreme physical conditions such as under water, rough terrain, difficult climatic conditions, in the body, in the air, etc.).

Develop promising and innovative robotic concepts (collaborative, modular and distributed, hyper redundant, highly reconfigurable, soft) enabling adaptation to transformations of industry and society (including crisis), and in addition to examine design methods and tools for novel configurations and concepts.

Proposals should investigate novel scientific approaches or push the limit of existing ones to improve physical capabilities of robots relevant to industry and service needs in sectors where this is a barrier to uptake, such as innovative actuation principles (such as soft robotics, reconfigurable, hyper-redundant, modular robotics), or advance the field of miniaturised robotics, advanced control, improved hardware and increased trustworthiness and dependability (e.g. building on the latest results in mechatronics, advanced sensing and actuation, advanced materials, chips for AI, neuromorphic computing). Where relevant, proposals are also encouraged to embed, starting from the design stage, techniques, methods and tools that enhance the performance and interaction of robots in real world tasks where testability is limited and a “first time right” mentality must prevail; for example in space exploration, in dense urban environments, when developing applications for vulnerable people, or in safety critical infrastructures such as nuclear reactors, pressure vessels or chemical storage tanks.

Proposals are expected to rethink robot bodies, with improved physical and interaction capabilities (with the environment and with humans taking into account gender, age and disabilities as appropriate) to reach novel or advanced abilities, such as powerful, fast, precise, and intrinsically safe navigation, manipulation, etc. capabilities. The shape and size of robots can vary from miniature to large-scale, from soft, to more rigid structure, from manipulators, to ground, air, marine, in-vivo, exoskeletons and wearable robots, etc. Such proposals could also propose innovative approaches in building on and integrating the latest developments in key underlying technologies, or by exploiting multimodalities (audio, vision, AR/VR, haptics, etc.), improved safety mechanisms, physical collaboration, collaborative and swarm robotics. In addition, proposal can address energy efficiency, to address the current limitation of energy autonomy in robotics. Proposals could also focus on advances in cognitive mechatronics, where sensing and actuation are closely coupled with cognitive systems to deliver improved autonomy, dexterity, control, motion quality, interaction (including all modalities), adaptation and learning, and safer systems.

Proposals should also take into consideration trustworthy AI principles, as appropriate.

Progress should be demonstrated by qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring. Activities are expected to achieve TRL 4-6 by the end of the project.

All projects should build on and reuse public results from relevant previous funded actions. Projects should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform⁹⁸, Digital Industrial Platform for Robotics⁹⁹, data platforms¹⁰⁰ and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms so as to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-07: Increased robotics capabilities demonstrated in key sectors (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

Expected Outcome:

Project results are expected to contribute to the following expected outcome:

- Pilots demonstrating the added value of robotics and their performances to address challenges in major application sectors, and in dangerous, dull, dirty tasks or those strenuous for humans or in extreme environments.

Scope: Integrate novel robotics technologies into solutions that are capable of autonomously taking over dangerous, dull and dirty jobs in a range of innovative applications or in reaching the level of reactivity, flexibility and adaptivity and natural intelligibility required for smooth and beneficial human-robot, as well as robot-robot collaboration and interaction. Engagement with SSH expertise is needed to improve human robot interaction design, behavioural intelligibility of robot interaction and action, especially in novel service applications, and to provide expertise on trustworthiness and acceptability by humans that impact at the design stage.

This topic will support innovation projects, expected to exploit the latest robotics advances and demonstrate at TRL6 or above use-case scenarios considering end-user needs and

⁹⁸ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

⁹⁹ <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

¹⁰⁰ E.g.: <https://www.big-data-europe.eu/>

expectations, in real or close-to-real environments, how they can directly contribute to the chosen application, supported by quantitative and qualitative industry or service related KPIs. Proposals need to make the case for the added value of such technologies, and demonstrating scalability, and short-term deployment potential. Progress should be demonstrated by appropriate KPIs, demonstrators, benchmarking and progress monitoring.

The proposals should be primarily application driven, with a concrete problem-solving approach, exploiting the most suitable robotics technologies at hand. The focus should be on real-world scenarios which can benefit in short term from the technology and demonstrate substantial impact on the chosen application, also taking into account the maturity of the technologies which can solve the problems at hand.

In case of shared workspaces, safe, dependable efficient and intuitive interaction will be key.

Considering that human factors and socio-economic aspects can limit or lessen efficient use of robots, human-centred and socio-economic approaches in combination with multi-stakeholder co-design activities can contribute to sustainable development of new enabling technologies. Putting people at the forefront will ensure novel transformation pathways, which help utilise existing technology in novel ways, and propose feedback loop systems that engage human users in developing new sociotechnical learning situations and tools. Further, agile sociotechnical learning designs, can remedy e.g., less efficient technologies, by emphasizing human aspects of technologies in any sector (for instance in, but not limited to, industry, healthcare, smart homes, etc.). For this, an interdisciplinary approach involving both technical and SSH, in particular ethics, researchers is needed to improve interaction design and to provide expertise on trustworthiness and acceptability by workers, and address gender equality and intersectionality where relevant.

The involvement of the user industry and the workers, possibly also the social partners, would be key to drive the proposals, not only to identify the needs and the application scenarios, but to be involved in the testing of the solutions and providing feedback to adapt the solutions to optimise the working conditions and performances. This is also essential for the acceptance of the technology. A human-centred approach will be key in all proposals, with deep involvement of the workers, professionals and other relevant stakeholders including experts in human-centred design, work safety, ergonomics, social partners or work organisation as appropriate. They will closely collaborate with the technology providers and integrators. The proposals should also take into consideration trustworthy AI principles including respect of human dignity and agency. Special attention will be given to including users of diverse age, gender and background.

Proposals are requested to dedicate at least 20% of their funding for FSTP to support SMEs or Start-ups in the development or enhancement of demonstrators, with a maximum of 200k€ per third party, and 70% of the costs ((100% for start-ups). The consortium will provide technical support with expertise in engineering integration, testing and validation to support the selected SMEs and start-ups acting as technology providers to demonstrate the added value of their solutions to address the challenges of the use-cases.

The selection of the application sectors should prioritize high impact sectors and use-cases where the technology can demonstrate maximum added value.

Each proposal will focus on one of the following use-cases:

- Demonstrating substantial added value of robotics in major application sectors with high socio-economic or environmental potential impact, improving the effectiveness and efficiency of processes or services
- Demonstrating how robotics can improve human working conditions and satisfaction in taking over dangerous, dull, dirty or strenuous tasks, keeping workers away from unsafe and unhealthy jobs

Proposals are encouraged, where appropriate, to develop configuration and deployment tools as well as tools for rapid configuration and re-configuration of robotics to improve deployability, reduce time to deployment, increase user driven (re)configuration, including through model-based approaches.

All projects should build on and reuse public results from relevant previous funded actions. Projects should make use of connections to the Digital Innovation Hub networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform¹⁰¹, Digital Industrial Platform for Robotics¹⁰², data platforms¹⁰³ and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms so as to enhance the European AI, data and robotics ecosystem through the sharing of results and best practice.

Proposals are expected to develop synergies with relevant activities in AI, Data and robotics, primarily in destination 1, 3, 4 and 6, but also in other destinations and clusters, and share or exploit results where appropriate.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

European leadership in Emerging Enabling Technologies

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-35: Advanced characterisation methodologies to assess and predict the health and environmental risks of nanomaterials

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

¹⁰¹ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

¹⁰² <https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/>

¹⁰³ E.g.: <https://www.big-data-europe.eu/>

<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome: The development of reliable and practical tools to ensure the safe and sustainable use of nanomaterials has not kept pace with the rapid commercialization of nanotechnology-enabled products. The dynamic nature of many nanomaterials in complex environmental matrices is recognized as a major challenge for their detection, quantification and characterization. Consequently, there is an urgent need to establish appropriate methods for cost-efficient assessment and prediction of the health and environmental effects of nanomaterials, providing better decision criteria, based on quantitative rather than qualitative information and taking into account the full life cycle of a material. Project results are expected to contribute to [all/some] of the following expected outcomes:

- Develop high-resolution imaging methods for quantification and characterization of nanomaterials (e.g. nanoplastics) in complex matrices and determinations of their transformations in such environments.
- Increase availability of validated protocols to advance both nanosafety studies and material characterization.
- Ensure appropriate control experiments and more realistic in vitro models to address current gaps in nanotoxicology.
- Deliver reliable data and improved data reporting guidelines, supported by computational modelling, in order to allow the development of grouping and read across methods.
- Develop harmonized standardized test methods that can be used in a regulatory framework including test hazard assessment, biodegradability and sustainability for advanced nanomaterials.
- Increase the efficiency and effectiveness of materials and product development by reducing costs and time for product design, time-to-market and regulatory compliance

Scope:

- Develop advanced characterization tools and methods for nanomaterials industry to enhance the design and development stages of advanced materials and products contributing to less waste and emissions while improving process quality in line with Life Cycle Assessment framework;
- Develop new in vitro models and tests to assess nanotoxicology;

- Include use cases to validate and demonstrate the approach(es) in industrial settings and involve comprehensive analysis and measurement of process and handling release scenarios and exposure measurements;
- Propose the validated methods to standardization bodies such as ISO or OECD for development of standards, test guidance or a guidance document;
- Demonstrate connectivity with H2020 nanosafety projects and leverage the extensive experience from relevant initiatives. Cooperation with EU funded projects under Industry Commons and other similar initiatives for interoperability and data documentation should be addressed;

In line with the Union's strategy for international cooperation in research and innovation, international cooperation is encouraged.

Flagship on Quantum Technologies: a Paradigm Shift

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-09: Specific Grant Agreement for developing the first large-scale quantum computers (SGA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum computing is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-15: Framework Partnership Agreement for developing the first large-scale quantum computers (FPA), each of the selected consortia will

be invited to submit a proposal that will implement the first 3 - 4 years (TBD) of the action plan defined in their respective FPA.

The proposal must progress the quantum computing platform in accordance with the research roadmap as defined in the FPA. This covers in particular progress in key areas such as the number of qubits to reach and the scalability potential, the fidelity / physical error rate, the further development of the underlying quantum computing processors and the low-level control of the programmability capability, the standardisation aspects, etc.

The proposal should describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific leadership. The proposal should detail activities in areas such as education, dissemination, ethics and societal aspects. It should also describe how it will grasp the technological potential in a way that accelerates innovation in all relevant application areas. Partners will be required to give other partners access to results needed for the purpose of any other specific actions under the FPA.

The proposal should also cover: (i) the cooperation with complementary projects launched specifically in the area of the enabling quantum software stack (see topic 4 below), including also the need to establish from the beginning of this cooperation appropriate IP exploitation agreements; (ii) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (iii) any additional support they may receive from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-10: Strengthening the quantum software ecosystem for quantum computing platforms (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply:

	Quantum computing is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.
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Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- develop quantum-specific algorithms and methods to apply them to problem-solving in a wide variety of industrial fields, giving European industry a competitive edge.

Scope: Fostering a European quantum computing industry will require hardware, software, and the development of user interfaces. Proposals should address the development of quantum-specific algorithms and methods to solve problems, for example in chemical and materials simulation, data analysis and optimisation, and space data processing and mission planning, as well as the more general development of novel quantum algorithms for yet unexplored application areas.

Proposals should target the development of quantum applications and the development of industrial use cases for the quantum computers of the Quantum Technologies Flagship (developed under topics (1) to (3) above). Furthermore, proposals should target the development of quantum software stacks, libraries, etc., that facilitate the link from a high-level description of algorithms to a low-level implementation with quantum gates, for solving concrete problems and applications expected to demonstrate quantum advantage. The developed applications and software should be independent of the underlying qubit platform and their correct functioning should be tested on as many quantum computing platforms as possible within the Quantum Technologies Flagship.

Proposals should also cover: (i) the cooperation with projects of the Quantum Flagship supporting quantum computing platforms, including also the need to establish from the beginning of such cooperation appropriate IP exploitation agreements; (ii) any additional support they may receive from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-11: Specific Grant Agreement for developing large scale quantum simulation platform technologies (SGA)

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

	different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum simulation is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-17: Framework Partnership Agreement for developing large scale quantum simulation platform technologies (FPA), each of the selected consortia will be invited to submit a proposal that will implement the first 3-4 years (indicative) of the action plan defined in their respective FPA.

The proposal must progress the quantum simulation platform in accordance with the research roadmap as defined in the FPA. This covers in particular progress in key areas such as the number of addressable individual quantum constituents, the level of control and scalability and achievement of a further entropy reduction of quantum simulators, the standardisation aspects such as the software interfaces with external systems, etc.

The proposal should describe how the activities carried out during the ramp-up phase will be continued involving the relevant disciplines and stakeholders, how results of the ramp-up phase will be used, and how they will provide efficient coordination under strong scientific leadership. The proposal should detail activities in areas such as education, dissemination, ethics and societal aspects. It should also describe how it will grasp the technological potential in a way that accelerates innovation in all relevant application areas. Partners will be required to give other partners access to results needed for the purpose of any other specific actions under the FPA.

The proposal should also cover: (i) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (ii) the eventual additional support they may receive from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-12: Specific Grant Agreement for building the Quantum Internet (SGA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum communication is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-19: Framework Partnership Agreements in Quantum Communications (FPA), selected consortium will be invited to submit a proposal that will implement the first 3-4 years (indicative) of the action plan defined in the respective FPA.

The proposal must progress the Quantum Internet Technologies in accordance with the research roadmap as defined in the FPA. This covers in particular progress in key areas such as enabling long-distance entanglement-based quantum communication.

The proposal should describe how any results of the ramp-up phase will be accessed and exploited, and how it will provide efficient coordination under strong scientific leadership. It should detail activities in areas such as education, dissemination, ethics and societal aspects. It should also describe how it will grasp the technological potential in a way that accelerates innovation in all relevant application areas. Partners will be required to give other partners access to results needed for the purpose of any other specific actions under the FPA.

The proposal should also cover: (i) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (ii) any additional support it may receive in its activities from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship. It should

also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-13: Specific Grant Agreement for Quantum encryption and future quantum network technologies (SGA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum communication is an emerging technology of global strategic importance. Other major players are investing heavily in it, and it has extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-19: Framework Partnership Agreements in Quantum Communications (FPA), the selected consortium will be invited to submit a proposal that will implement the first 3-4 years (indicative) of the action plan defined in the respective FPA.

The proposal must progress the Quantum encryption and future quantum network technologies field in accordance with the research roadmap as defined in the FPA.

The proposal should describe how any results of the ramp-up phase will be accessed and exploited, and how it will provide efficient coordination under strong scientific leadership. It should describe how it will grasp the technological potential in a way that accelerates innovation in all relevant application areas. Partners will be required to give other partners access to results needed for the purpose of any other specific actions under the FPA.

The proposal should also cover: (i) the collaboration with other initiatives or programmes at regional, national, transnational or global level; (ii) any additional support it may receive in its activities from relevant national, or regional programmes and initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship and the

EuroQCI initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-14: Specific Grant Agreement for supporting open testing and experimentation for quantum technologies in Europe (SGA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum technologies are an emerging field of global strategic importance. Other major players are investing heavily in them, and they have extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA), the selected consortium will be invited to submit a proposal that will implement the first 3 - 4 years (TBD) of the action plan related to the pan-European provision of open testing and experimentation facilities defined in the FPA.

The proposal must progress the open testing and experimentation capability of European academic and industrial players, especially of start-ups and SMEs, in accordance with the technology/capability innovation roadmap as defined in the FPA. This covers in particular progress in establishing a well-connected network providing access to open testing, and experimentation facilities in Europe, as well as access to unique competences and know-how centred at various locations in Europe.

The network should be a ‘one-stop-shop’ to make state of the art hardware, experimental instrumentation and related facilities, technologies and tools as well as knowledge and expertise in quantum technologies available to European scientists, engineers and industry

players, especially start-ups and SMEs, with the aim of establishing an inclusive and effective quantum technologies lab-to-market ecosystem in Europe.

By enabling innovation experiments, the network will deliver improved design processes, better products and services, shorter time-to-market and improved innovation and competitiveness capabilities.

The proposal should also cover: (i) the collaboration with other initiatives or programmes at regional, national, or European level; (ii) the eventual additional financial support they may receive in their activities from relevant national or regional initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-15: Specific Grant Agreement for supporting experimental production capabilities for quantum technologies in Europe (SGA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum technologies are an emerging field of global strategic importance. Other major players are investing heavily in them, and they have extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

Scope: Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-01-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA), the selected consortium will be invited to submit a proposal that will implement the first 3 - 4 years (TBD) of the action plan for providing pilot fabrication

capabilities defined in the FPA that would foster product development and rapid innovation especially for European industry, in particular start-ups and SMEs.

The proposal should aim to establish experimental (pilot) production capabilities for a first of their kind quantum technologies, where European companies, research centres and academic institutions can produce novel devices on a pilot scale based on a shared cost model between users and service providers.

Each of the targeted experimental (pilot) lines should have a simple baseline process ready in 2-3 years (TBD) from start of the project and the full flow should be ready during the lifetime of the FPA. The development and operation of each experimental pilot line will be coordinated closely with the core projects of the Quantum Flagship through a dedicated collaboration agreement.

The action will require expertise in the area of manufacturing flows for quantum technologies, in particular in quantum computing (for e.g. qubit fabrication), communication and sensing, and with issues regarding reliability, versatility, process control including integrated testing and minimizing lead times. Where necessary such expertise should be brought into the consortium under proper consideration of IP issues.

The action should demonstrate how it federates key competences in the whole innovation value chain, from business-model development to first fabrication, through a balanced and inclusive network of RTOs, small foundries, unique manufacturing providers, and other key innovation players, effectively acting as fabrication laboratories.

The proposal should also cover: (i) the collaboration with other initiatives or programmes at regional, national, or European level; (ii) any additional financial support they may receive in their activities from relevant national or regional initiatives; and (iii) contribution to the governance and overall coordination of the Quantum Technologies Flagship initiative. It should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-16: Basic Science for Quantum Technologies (RIA)

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

<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Quantum technologies are an emerging field of global strategic importance. Other major players are investing heavily in them, and they have extensive uses in security and defence. In order to protect the essential interests of the EU in this highly sensitive field and ensure that European security is not compromised, we propose to apply Art. 18.5 to this topic.</p>

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

- Opening up new avenues for potential growth in the field of quantum technologies
- Novel concepts, leading to more advanced technologies continue to support the basic science research carried out by the Quantum Technologies Flagship, ensuring that it informs the Flagship's work in other quantum fields, and/or explores new directions within existing fields.

Scope: Proposals should aim to explore new quantum effects and gain new knowledge that is not limited to the pillar activities, and which may contribute to new quantum technologies and applications in the long term. Areas of particular interest include quantum information theory, the identification of new laws and limits, understanding the mechanisms behind decoherence, the development of certification methods for quantum technologies, and research that goes beyond the field of pure quantum technologies, such as the study of quantum effects in thermodynamical or biological processes.

The technological resources include strategic components, ranging from fundamental properties to engineering quantum devices and systems (TRL 2-4) to interfacing these across different, always with a view towards end-user applications and their operation. Examples are: light sources, interfaces including manipulation of light, and single photon detectors, which are compatible and interoperable. The development of new materials, single integrated solutions or hybrid integrated solutions that are miniaturised and scalable, fabrication and packaging solutions, are also key challenges, as is the development of new protocols, control approaches and algorithms.

Proposals should contribute to (i) the governance and overall coordination of the Quantum Technologies Flagship initiative, (ii) where relevant to inter-project cooperation, in particular with the 4 main pillars of the Quantum Technologies Flagship (quantum computing, quantum simulation, quantum communication and quantum sensing and metrology). They should also contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-25: Training and Education on Quantum Technologies (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Define a European core curriculum for quantum technologies to prepare postsecondary students for the challenges arising in quantum industry and academic research.
- Facilitate access to services and training offered to interested postsecondary students, workforce and other potential users (from industry, academia or public sector)
- Addressing the skills gap in quantum technologies-related domains by specialised training to develop the human capital resources to address increased skills need in industry (including SMEs).
- Create training programme curricula in close cooperation with industry for the quantum workforce according to the specific skills required by the quantum and end user industry.
- Implement innovative research-based curricula in quantum technologies for the university and secondary school education levels in all European countries.

Scope: Proposals should perform an extensive mapping of current and future requirements for education and training; define standards for implementing appropriate educational strategies; host existing and newly developed teaching materials and resources within a repository; develop strategies for scaling up advanced quantum technology training programmes across Europe; and establish a network between science, civil society, and industry to exchange ideas, needs, and human resources (e.g. in the form of student internships). In doing so, they should work in close cooperation with the Flagship project actors.

Proposals should also address the coordination of the education activities and strategies they would work upon with the relevant national actors.

Proposals should involve and be driven by representatives of the relevant actors of the field (e.g., academia, RTOs, and industry, including SMEs, and intermediaries). They should also

contribute to spreading excellence across the European Research Area; for example, through the involvement of Widening Countries.

Proposals should take into account synergies with activities in advanced digital skills supported by the Digital Europe programme.

Graphene: Europe in the lead

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-17: New generation of advanced electronic and photonic 2D materials-based devices, systems and sensors (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- New technological solutions with improved performance and reduced energy consumption providing significant advances towards the integration of 2D materials (2DM) technology in the semiconductor arena, and the emergence of competitive value chains in graphene in Europe.

Scope: Proposals should cover the development of 2DM-based devices and systems bringing 2DM technology one step further towards the integration in current semiconductor technology and to the development of radically new prototypes and/or solutions for industry for a wide range of application areas overcoming integration costs, functionalities and/or power consumption challenges. The proposals should develop 2DM-based electronic and photonic devices including ultrafast circuits, photodetector, and modulators, broadband detectors, switches, as well as sensors, advanced electronics, metamaterials, etc., serving applications such as 5G and 6G data communications, wireless connections, smart machine vision, autonomous robots and vehicles, internet of things, and neuromorphic circuitry and/or image applications. The 2DM-based devices and systems should demonstrate their added value in terms of e.g. functionality, integration, miniaturization, performances, power consumption, costs, etc. compared to current conventional technologies.

Proposals should address a modelling, design, manufacturing and characterization of developed devices and systems. The proposals should also explore, develop and assess the route(s) for integration (e.g. wafer growth, transfer, wafer scale integration, co-integration) of 2DM into the devices and systems favouring industrial uptake in the longer-term.

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5-6).

Proposals should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-18: 2D materials-based devices and systems for energy storage and/or harvesting (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Demonstrated added value of 2D materials (2DM) for energy storage devices and systems in applications where Europe can build competitive value chains.
- New technology solutions for portable energy sources outperforming alternative technologies e.g. in terms of energy and power density, operational safety, long-term stability, mechanical flexibility, light weight, thin thickness, and low cost that will enable the rapid development of power-demanding smart devices, Internet of Thing (IoT) sensors and wearable electronics.

Scope: Proposals should develop solutions demonstrating the potential added value of 2DM-based energy storage like large energy storage technologies, beyond current Li-ion, for electric power grids/solar farms/wind farms with increased performances in terms of durability, safety, energy density and power density.

Proposals should also work on structural batteries and structural supercapacitors and related production techniques, i.e. energy storage devices integrated in structural parts of e.g. airplanes or cars, to address the demand of distributed sensors and electronics, functional printed micro-flexible supercapacitors for e.g. IoT applications are included as well.

Proposals addressing energy harvesting should investigate/establish proof of concepts/develop 2DM-based devices for energy conversion that can produce electricity in response to e.g. light, moisture, flowing liquid, friction, pressure force, or heat with unprecedented characteristics or unique functionalities.

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5-6).

The proposal should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-19: 2D materials-based devices and systems for biomedical applications (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- New technology solutions exploiting the unique properties of 2D materials (2DM) that would reduce cost and increase the efficacy of diagnostics or therapies, or provide new diagnostics or therapies for which there is currently no solution. It would strengthen Europe's industrial position in, early diagnostics, disease prediction and prevention, disease monitoring and reducing hospitalization time.

Scope: Proposals should build on the multi-functionality allowed by 2DMs and demonstrate the advantages of combining e.g. biocompatibility, chemical stability, (bio-)sensing and actuating, and integration with flexible electronic technologies, in addition to versatile surface chemistry (for interface with biology) to allow built-in pharmacological interventions.

Emphasis of the proposals should have a translational perspective, addressing how the devices and systems will reach the clinic, preferably led by European industry. Furthermore, the proposals should bring together multidisciplinary teams including engineers, material scientists, pharmacologists, biologists, clinicians, patients, and ethics experts. Potential application areas include: Engineering & bioengineering of bioelectronic diagnosis or therapeutic devices and platforms, sensors for digital health, Electronics for brain-computer

interfaces, taking advantage of flexible devices, Medical imaging in combination with implantable devices (e.g. MRI), graphene for drug delivery of therapeutics (e.g. for neurological disorders).

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5-6).

The proposal should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-22: Supporting the coordination of the Graphene Flagship projects (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- A strong and coherent graphene and 2D materials (2DM) initiative by providing key support functions, enabling participating projects to find synergies in their work and share best practice, and favouring interactions and synergies with national and regional initiatives, projects and infrastructures in the domain.

Scope: Proposals should address the need to guarantee a sustained European leadership in 2DM, capitalise upon the investments made so far in graphene, exploit synergistically the scientific, technological and innovation outcomes of these investments and deliver benefits to the European society. Proposals should support the coordination of the Graphene Flagship initiative projects that would be selected under the call topics of the initiative. They should address all the coordination and support functions necessary to build a strong Flagship initiative, including: Governance, Community engagement, Dissemination, communication, outreach, dialogue with the public, etc. They should also work on creating new education and training curricula, promoting Innovation, developing Research and innovation roadmap activities, liaising with and supporting the coordinating with relevant national and regional 2DM activities and establishing and supporting the dialogue with other international relevant programmes and initiatives in the field.

Proposals should involve and be driven by representatives of the relevant actors of the field (e.g., academia, RTOs and industry, including SMEs).

DRAFT

DESTINATION 5 – OPEN STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA

Today EU citizens enjoy watching satellite TV, increasingly accurate global navigation services for all transport modes and users (e.g. mobile phones and car navigation systems), extended Earth monitoring for land, marine, atmosphere and climate change, global meteorological observation and accurate cartographies of a wide number of variables. Space also makes important contributions to security crisis management and emergency services. These are key assets for the EU policies on climate, environment, transport, agriculture and secure society (e.g. Maritime Strategy, the Arctic Strategy, the Digital Agenda, the Common Security and Defence Policy, the Sustainable Development Strategy, the SDGs). Finally, the space sector is a source of economic growth, jobs and exports.

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- A, **‘Promoting an open strategic autonomy 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.’
- B, **‘Restoring Europe’s ecosystems and biodiversity, and managing sustainably natural resources** to ensure food security and a clean and healthy environment.
- C, **‘Making Europe the first digitally led circular, climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems.’
- D, **‘Creating a more resilient, inclusive and democratic European society**, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.’

Proposals for topics under this Destination should set out a credible pathway to contributing to the following expected impact:

Open strategic autonomy in developing, deploying and using global space-based infrastructures, services applications and data, including by reinforcing the EU’s independent capacity to access space, securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector competitiveness.

This expected impact is fully in line with the Space Strategy for Europe and the proposal for the Space Programme. Horizon Europe R&I funds will contribute to this expected impact along 2 main axes by:

- providing support with R&I funding to the EU space sector at large
- making a specific impact with the EU action with R&I to prepare the future evolutions of the Space programme components

This Destination is therefore structured along the following headings:

1. Foster competitiveness of space systems
2. Reinforce our capacity to access to space
3. Evolution of Space and ground infrastructures for Galileo/EGNOS
4. Evolution of services for Galileo, EGNOS and Copernicus
5. Development of applications for Galileo, EGNOS and Copernicus
6. Innovative space capabilities: SSA, GOVSATCOM, Quantum
7. Space entrepreneurship ecosystems (incl. New Space and start-ups) and skills
8. Targeted and strategic actions supporting the EU space sector

While headings 1, 2, 7 and 8 will support the EU space sector at large and are largely based on the recommendation of Strategic Research and Innovation Agenda, headings 3), 4), 5), and 6) will be supporting the Space Programme components as well as the quantum emerging initiative.

All headings will contribute to the 'Open strategic autonomy in developing, deploying and using global space-based infrastructures'. This is the underlying goal when investing in R&I to ensure the future of existing space programme components infrastructures, services and applications (Heading 3) and with R&I to investigate new future services (Heading 4). This autonomy would however not be complete if we would not have the capacity to access space and launch these infrastructures (Heading 2) and propose opportunities for In-Orbit Demonstration and In-Orbit Validation (Heading 8). As the EU space sector relies on a smaller share of institutional investments compared to other regions, this difference needs to be compensated by a more competitive sector (Heading 1). R&I and a strategy for critical technologies for non-dependence is another important axis of action (Heading 8). A guarantee for such autonomy is also to have a vivid and competitive downstream sector entrepreneurship eco-systems in the EU (Headings 5 and Heading 7). A description of the headings objectives and targeted achievements is provided below.

Foster competitiveness of space systems

The European space sector and space economy needs to improve space-based capabilities, capture new markets, adapt to rapidly changing markets whilst staying competitive in the satellite communication, navigation and Earth observation sectors. This requires development of new competitive technologies for space and ground systems, such as very high throughput satellites, very high resolution sensors, radiation-hard electronics, on-board and ground

Artificial Intelligence (AI), optical communication and quantum technologies, as well as contributions from robotics. We also need to prepare the ground for future modular, flexible and intelligent satellites. In the mid to long term, the future space ecosystem should include hybrid, smart and reconfigurable satellites, which can be manufactured, assembled and serviced directly on-orbit, and with a de-orbiting capacity.

Digitalisation and automation will enable advanced design and manufacturing methods (including additive manufacturing) and “Digital Twins”, plug-and-play modularity, as well as model based system engineering. This will yield reductions in mass, cost, emission, energy consumption and development time.

Disruptive technologies and concepts should be pursued to bring breakthrough innovation to the space sector, while at the same time furthering technology maturation in the view of qualification on ground or via In-Orbit Demonstration and Validation activities.

Reinforce EU capacity to access to space

Two specific challenges stand out. Firstly, the highly competitive global launch service market landscape characterised by an increasing number of competitors, secondly, the emerging opportunities in space transportation that are not yet seized by European launch actors characterised by new uses of space (e.g. small satellites, larger constellations, payload recovery, payload quick deployment), new services (e.g. direct orbit injection, in-orbit servicing) and in-space transportation. This will require, amongst others, new concepts for reducing the production and operation cost such as reusability (including stage recovery and landing) of launcher and vehicle components, and low cost, high thrust and green propulsion, modular avionics, autonomous systems, micro launcher solutions, re-entry vehicles and modern and flexible test and launch facilities. Both will require urgent activities in order to enable operational capacities at the latest by 2030.

Disruptive technologies, methodologies and concepts should be pursued to bring breakthrough innovation to the launcher systems sector towards cost reduction and contribute to the preparation of competitive European Space Transportation beyond 2030.

Evolution of Space and ground infrastructures for Galileo/EGNOS

For Galileo/EGNOS, the international context, the competitive environment with emerging actors and novel techniques in the value chain, the increasing threats, and the evolution of the technologies, components and systems, including dual-use technology, call for a constant adaptation of the EU space infrastructure to these changing realities.

To meet these challenges, sustained investments in R&D for innovative mission concepts, technology and systems are needed. They will ensure the continuity of EGNSS service, minimize the risks for technology inclusion in the infrastructure thanks to anticipated development and testing including in orbit, protect this infrastructure against modern threats is reinforced (notably cyber, jamming/spoofing, natural hazards), and increase the strategic autonomy on key technologies. Overall, keeping the EU’s position at the avant-garde of the Global Navigation Satellite Systems.

Evolution of services for Galileo, EGNOS and Copernicus

Copernicus core services (Climate, Marine environment, Land monitoring, Atmosphere monitoring, Emergency management and Security) must evolve and improve to better respond to new and emerging policy needs, such as anthropogenic CO₂, GHG and pollutant monitoring, climate change mitigation and adaptation, EU arctic policy, coastal area, sustainable development goals, environmental compliance, protection of natural resources, ecosystems and biodiversity, food security, agriculture, fisheries, aquaculture, crisis management, safe transport, sustainable, clean energy, border management, cultural heritage, as well as other new domains that could bring key contributions to the European Green Deal and to other EU priorities.

Similarly, the Galileo service portfolio (High precision positioning, navigation and timing, authentication, search and rescue and Public Regulated Service, PRS) must be adapted to the evolution of the user needs and market trends. This requires to introduce new services and capabilities serving at best the downstream application sector, so that EGNSS remains at the fore front of the provision of satellite positioning, navigation and timing (PNT) services and keeps the pace with increasing global competition in the sector (USA, China, 5G, etc.). Extending Galileo services in various societal challenges and offering it as a complementary service to emerging markets like 5G, CCAM and AI.

Development of applications for Galileo, EGNOS and Copernicus

We need to make the best use of EGNSS and Copernicus capacities for EU citizens, companies and society. Research and innovation should therefore foster the development of EGNSS downstream applications and promote their adoption in the EU and worldwide, in particular in long lead-time markets (e.g. maritime, rail, aviation), and in areas where Galileo offers unique differentiators (high accuracy, authentication, Search and Rescue, PRS).

Copernicus based applications and services can serve, for example, polar research, monitoring of the environment, maritime and coastal monitoring, natural disasters, migration, agriculture and can bring, with EMODnet and EGNSS, a key contribution to the European Green Deal and to the sustainable management of natural resources. The public sector should be supported as customer of space based technologies via innovation procurement. Synergies between Galileo/EGNOS and Copernicus, as well as synergies with non-space programmes, leveraging the combination of space data with non-space data, will open new avenues for a wealth of new and innovative applications and services, still to be invented.

Innovative space capabilities: SSA, GOVSATCOM, Quantum

Space Situational Awareness (SSA) and GOVSATCOM innovative components will be developed in the EU Space programme fostered by Horizon Europe R&I. Quantum Technologies, as an emerging field with great potential to be applied in the EU Space programme, requires foundational research and validation activities for its space component.

Space Situational Awareness (SSA) will provide services to European users including spacecraft owners/operators and governmental entities that will reinforce the protection and

resilience of European space and ground infrastructures against various hazards and risks (mainly collisions in/from space, Near Earth Objects or space weather events). New challenges are posed by the ever increasing orbital population of smaller satellites and space debris and the associated increased risk of orbital collisions, fragmentations and re-entries. R&I activities shall address these challenges by developing novel architectures and technical solutions for ground/space sensors, data processing, networking and operation centers (including critical technological elements for the realization of crucial future space weather applications and services) to ensure safety and sustainability of space operations in Europe as well as by improving current EUSST services and implementing new ones (space debris mitigation and remediation services; space weather services).

The **GOVSATCOM** initiative aims to provide reliable, secured and cost-effective satellite communications services to EU and Member State authorities with an infrastructure supporting secure critical missions and the ability to exchange sensitive information in a hybrid threats environment worldwide (including the Arctic). Research and innovation activities will foster the development of European satcom security related technologies and increase European independence from foreign critical technologies and exploiting synergies with Copernicus and Galileo and with defence /security assets.

Space will pave the way for **quantum technologies** in EU space infrastructure and for space-based services (e.g. quantum inter-satellite communication, next generation atomic clocks or quantum sensors). It is of highest strategic importance for the EU and its industry to be competitive and to become a global leader in this area. It will provide enhanced services to EU citizens and allow to overcome limitations and challenges of the current generation of quantum technologies. Therefore, R&I shall foster the development and use of EU sourced space qualified quantum components, including mission design, integration and in-orbit demonstration and validation. The availability of adequate ground segment infrastructure for testing and validation the quantum space mission needs also to be ensured. Synergies with GOVSATCOM will be thought.

Space entrepreneurship ecosystems (incl. New Space and start-ups) and skills

Business development, acceleration and upscaling of start-ups will be fostered across all space areas under the CASSINI Space Entrepreneurship Initiative.

Support will be provided to foster business and innovation-friendly ecosystems, including strengthening business skills in the space market segments and digital services based on space data. The objective is to make the companies investment-ready and able to secure venture capital funding. There will funding and synergies with the InvestEU programme and the Space programme.

Targeted and strategic actions supporting the EU space sector

Development of associated technologies and actions of key importance to the sections described above will be pursued. These actions will at the same time contribute to foster the

competitiveness of the EU space sector to reinforce our capacity to use and access space and to R&I for the Space Programme.

These targeted and strategic action include the development of critical technologies for EU non-dependence, the establishment of regular and cost-effective flight opportunities for IOD/IOV, space science activities, as well as outreach, education and international cooperation activities.

Note on delegation

Part of the Horizon Europe space activities related to downstream applications and entrepreneurship for the period 2021-2027 will be implemented by a delegated entity in indirect management in accordance with Article 62(1)(c) of the Regulation (EU, Euratom) 2018/1046 on the financial rules applicable to the general budget of the Union, repealing Regulation (EU, Euratom) No 966/2012 (the "Financial Regulation"). The delegated entity will use grants, procurement, prizes and financial instruments within blending operations as forms of funding in accordance with Article 6 of the Regulation (EU) No XXX/202X establishing Horizon Europe. In accordance with Article 3 of that Regulation Horizon Europe shall fund neither the construction nor the operation of the European space programme components.

The delegated entity will manage all the phases of the project lifecycle in accordance with the procedures set out in the Horizon Europe regulation and with due regard to the Regulation (EU) No XXX/202X on the European space programme, where appropriate. To this end a Financial Framework Partnership Agreement and a contribution agreement covering the activities financed under 2021-2027 budget will be concluded between the Commission and the delegated entity, setting out in detail the entrusted tasks and the arrangements ensuring the protection of the financial interests of the Union.

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

Call	Budgets (EUR million)Deadline(s)
HORIZON-CL4-2021-SPACE-01	
HORIZON-CL4-2021-SPACE-02	
HORIZON-CL4-2022-SPACE-01	
HORIZON-CL4-2022-SPACE-02	
Overall indicative budget	

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2021

HORIZON-CL4-2021-SPACE-01

Conditions for the Call

Indicative budget(s)¹⁰⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁰⁵	Number of projects expected to be funded
HORIZON-CL4-2021-SPACE-01-11	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-12	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-21	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-22	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-23	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-41	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-42	RIA	Around N/A	Not relevant	

¹⁰⁴ 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 2021 and 2022.

¹⁰⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2021-SPACE-01-43	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-44	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-61	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-62	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-81	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-01-82	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Foster competitiveness of space systems

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-11: End-to-end satellite communication systems and associated services

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

Expected Outcome: The expected outcomes of this topic will enable flexible satellite communication with high productivity and growing data and service requirements. Security aspects should be considered in all targeted developments. The demand in term of

competitiveness will be satisfied by providing growing capacity per system, as well as flexibility and agility to face uncertainties and market evolutions and improving system availability and latency to deliver high-quality experience to end-users.

Projects are expected to contribute to one or several of the following outcomes:

- Capture 50% of global accessible Telecom satellite market by 2028.
- Showcasing a secure, flexible and competitive end-to-end-system aiming a ground demonstrator by 2026/27.
- Short to mid-term disruptive development and maturation of key technologies (up to TRL6) for high performance and secure communication systems.
- Support the EU space policy and end-to-end secure communication by paving the way for the deployment of a future EU secure and global satellite quantum communication capacity.
- Ensure EU non-dependence for the development of quantum communication technology in space.
- Enhance the TRL to 5-6 of the components necessary to build a quantum satellite communication capacity using EU technology in preparation of an IOD/V.
- This will contribute to developing, deploying global space-based services applications and data and contribute to fostering the EU's space sector competitiveness, as stated in the expected impact of this destination.

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

1) R&I on secure quantum communications by the development of components for quantum satellite communication systems as well as of space technology components and systems necessary for Quantum Key Distributions (QKD), e.g. space compatible Quantum Random Number Generators (QRNG), single or entangled photon sources, decoy state systems, associated electronics, systems for key management and storage, single photon detectors and super accurate pointing mechanisms, protocols and standards, quantum specific on-board computers as well as novel user authentication mechanisms. This area also includes the tools necessary to simulate, control and monitor the space quantum information networks, development and/or use of testbeds or any other system used to recreate or simulate the space environment to test quantum satellite communications technology components.

2) R&I on ground segment, infrastructures, networks including end-user terminals and equipment considering the handling of a range of new needs (e.g. introduced by satellite constellations, increasing data rates, flexible ultra-high throughput satellites, higher on-board and on-ground-autonomy, millimetre wavelength communication in Q/V, W-band), providing scalable and resilient solutions while reducing costs.

3) R&I on satellite data management in view of a full digitalisation of the payload, on-board data processing and processing for end-to-end performance, e.g. by developing flexible and scalable software (e.g. AI based, etc.) and hardware (advanced processing units, cloud-based or mass storages, etc.) solutions.

Proposal should address only one area. To ensure a balanced portfolio covering the three areas described above, grants will be awarded to applications not only in order of ranking but at least also to one proposal that is the highest ranked within each area, provided that the applications attain all thresholds.

Actions on quantum communication technology are related to the Union strategic assets, interests, autonomy and security, for the protection of the essential security interest of the Union and its Member States, in particular with regard to the need to preserve the integrity and resilience of the Union systems, as well as the autonomy of the industrial basis on which they rely. For these reasons, the participation to the actions shall be limited to legal entities established in the EU Member States and effectively controlled by Member States or nationals of Member States.

Proposals are expected to promote cooperation between different actors (industry, SMEs and research institutions) and consider opportunities to quickly turn technological innovation into commercial space usage.

Proposals under this topic should exploit synergies and be complementary to already funded actions in the context of technology development at component level. In particular, the topic: Critical Space Technologies for European non-dependence (H2020 SPACE-10-TEC-2018-2020, H2020 COMPET-1-2014-2015-2016-2017). Furthermore, activities shall be complementary to national activities and activities funded by ESA, while providing EU non-dependency.

HORIZON-CL4-2021-SPACE-01-12: Future space ecosystems: on-orbit operations, new system concepts

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	The conditions are described in General Annex B. The following exceptions apply:

	Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.
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Expected Outcome: Enable the industrialisation and new services in space by intelligent solutions and concepts, exploiting synergies with terrestrial sectors and cultivating an *AppStore* and *Open-Architecture* mentality.

Solutions should consider a new paradigm stating ethical interests towards civil and environmental protection. Therefore, automation, robotics and artificial intelligence (AI) especially in combination with standardisation, modularisation and digitalisation are key enablers, improving space systems and satellites' flexibility and cost-efficiency, increasing sustainability and accessibility, introducing mass-customisation and cooperative design as well as simplifying operations.

Each project is expected to contribute to one or several of the following outcomes:

- A future space ecosystem, fostering the industrialisation and business in space as well as supporting scientifically meaningful missions by using synergies with terrestrial sectors, building on spacecraft modularity, simplifying operations and make *plug-and-play* modules more common as well as enabling on-orbit services such as maintenance, assembly, manufacturing, re-configuration, recycling, logistics, warehousing, etc.
- Game-changing technologies, tools and processes enhancing on-orbit servicing applications and contribute to the protection of the in-space future ecosystem
- A paradigm shift towards sustainable, highly automated, flexible and economical viable space infrastructure, to maximise commercial opportunities in space and on Earth.

This will contribute to, in the medium to long term, developing, deploying global space-based services and contribute to fostering the EU's space sector competitiveness, as stated in the expected impact of this destination.

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

1) R&I on new scaleable satellite platform concepts and building blocks increasing the degree of satellite modularisation. Aiming at intelligent, adaptable and maintainable systems with *plug-and-play* compartmentalised functionalities (modules) that will introduce both, on-orbit re-configuration and re-use/re-cycling of spacecraft parts fostering debris mitigation, as well as increased system redundancy, inherently (e.g by blockchain paradigm). As one result, functional satellite modules (Orbital Replaceable Units to deliver new/enhanced functionality) should be developed (TRL 5-6) to upgrade the satellite platform of the orbital demonstration mission¹⁰⁶ by using pre-existing standard interfaces¹⁰⁷ (*plug-and-play* concept). The module

¹⁰⁶ To be developed under topic HORIZON-CL4-2022-SPACE-01-11

design should support the integration of different pre-existing standard interfaces¹¹³. Further reference is given in a technical guidance document¹⁰⁸.

2) R&I on new on-orbit services concepts concentrating on next generation of business cases (e.g. satellite recycling, transfer services, logistics, warehousing, etc.) aiming at a sustainable space infrastructure and contribute to protection of in-space ecosystem. Work should include - but not limited to- market & trend analyses, design of mission and system architecture, and feasibility studies.

3) R&I to identify, develop and implement AI and industry 4.0 means (e.g. virtual design, digital twins, virtual testing) in order to attain *Rapid Development, Production* and *AIT* processes in satellite life cycle.

4) R&I to develop an innovative, scalable and adaptive framework concept for a ‘*European construction kit for satellite systems and applications*’, following the *AppStore* approach and fostering development of compartmentalised functionalities (modules) for satellite systems independently from mission. The framework should address the needs from building block developers as well as from end-users.

Relevant and promising solutions derived in Horizon 2020 activities should be exploited where possible, especially project results from the Strategic Research Clusters *Space Robotics Technologies*¹⁰⁹ and *Electric Propulsion*¹¹⁰.

A proposal may address more than one area and is expected to promote cooperation between different actors (industry, SMEs and research institutions) and consider opportunities to quickly turn technological innovation into commercial space usage.

To ensure a balanced portfolio covering the four areas described above, grants will be awarded to applications not only in order of ranking but at least also to one project that is the highest ranked within each area, provided that the applications attain all thresholds.

Reinforce EU capacity to access and use space

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-21: Reusability for strategic space launchers - technologies and operation maturation including flight test demonstration

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

¹⁰⁷ Multi-functional interface for OOS applications providing at least transfer of mechanical loads, power and data, (e.g. HOTDOCK, iSSI or SIROM)

¹⁰⁸ Published on the EU funding and tenders portal (<https://ec.europa.eu/info/funding-tenders/opportunities/portal>)

¹⁰⁹ www.h2020-peraspera.eu

¹¹⁰ www.epic-src.eu

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<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

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

- Contribution to the overarching objective of launch cost/price reduction by 50% by 2030, for the benefit of EU Space programmes implementation and towards reinforcing EU's independent capacity to access to space.
- Innovation acceleration of enabling technologies (maturing, assessing and practicing, through representative in flight experiments).

- Matured technologies up to TRL5/6, integration of demonstration vehicle, on-ground and low altitude demonstration tests by 2023 and contribution to the preparation of suborbital demonstration tests potentially in 2025.
- Cost reduction investigation and demonstration.

These outcomes will contribute to enhance EU strategic autonomy and sector competitiveness, in line with the Expected Impact of the destination.

Scope: Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

R&I will focus on reusability concepts including required technologies that have a strong potential for cost reduction, starting with the recovery of the most expensive components such as first stage. It can also increase launch flexibility by reducing lead-time from order to launch by helping to adapt efficiently the launch rate and the performance to market variations. In addition, reusability would contribute to align space economy with the ecological transition to sustainability.

The activities will address technologies and building blocks maturation up to TRL5/6 and subsystem/system demonstrations including prototyping, demonstration, vehicle integration, ground tests, low altitude flight demonstration tests by 2023/24 and contribution to the preparation up to ground based system tests of suborbital flight demonstration tests by 2025/26. The execution of the suborbital tests is not part of the scope.

The developed enabling technologies and building blocks shall be applicable to strategic launchers able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030. The demonstration vehicle shall be representative of a reusable 1st stage of a strategic EU launcher. This vehicle shall be at a sufficiently large scale in order to be representative of the expected final capacities. The vehicle will be equipped with a reusable propulsion system.

The proposed activities shall also support EU non-dependence objective and include the assessment of costs reduction investigations and demonstrations results towards the overarching objective mentioned in the expected outcomes.

The activities will address enabling technologies maturation and demonstration at least in all of the following areas:

- low cost GNC and avionics (hybridation techniques, navigation sensors, modular, reconfigurable),
- maneuvering control devices,
- HMS (Health Monitoring System), propellant management,
- aerodynamic devices,

- descent and landing/recovery systems,
- on-ground servicing processes (refurbishment, check-out and repair and recertification for reused elements),
- safety critical processes before launch and after landing.

All the activities shall be complementary and coherent with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019 (reference to guidance document to be inserted).

HORIZON-CL4-2021-SPACE-01-22: Low cost high thrust propulsion for strategic space launchers - technologies maturation including ground tests

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to</p>

	Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Contribution to the overarching objective of launch cost/price reduction by 50% by 2030, for the benefit of EU Space programmes implementation and going towards reinforcing EU's independent capacity to access to space.
- Innovation acceleration of enabling technologies (maturing, prototyping, on ground tests)
- Identified and matured concepts up to TRL 3-4 for cost-reduction possibilities in the current European launchers, matured technologies up to TRL 5-6 by 2023/24, prototyping and on ground tests at engine subsystem and system level by 2025/26
- Cost reduction investigation and demonstration.

These outcomes will contribute to enhance EU strategic autonomy and sector competitiveness, in line with the Expected Impact of the destination.

Scope: Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

The propulsion systems represent a significant part of launch system costs. It is necessary to mature new or optimised low cost effective (lower number of parts, better operability), high performance (high thrust to weight ratio, high specific impulse) and green propulsion concepts, technologies and propellants for high thrust engines.

The activities shall address maturation of enabling technologies, building blocks, tools and processes including maintenance/overhaul and safety, up to TRL5/6 and subsystem/system demonstrations including prototyping and functional tests at subsystems level and on-ground demonstration tests at engine level.

The matured technologies, building blocks, tools and processes shall be applicable to strategic launchers able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030 and preferably earlier for current launch solutions. The demonstration tests shall be appropriate to this objective.

The proposed activities shall also support EU non-dependence objective and include the assessment of costs reduction investigations and demonstrations results towards the overarching objective mentioned in the expected outcomes.

The activities will address one or several of the following areas:

- low cost propulsion,
- throttability,
- reduced number of parts with extensive application of Additive manufacturing,
- maintenance/overhaul,
- associated fluidics,

All the activities shall be complementary and coherent with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019 (reference to guidance document to be inserted).

HORIZON-CL4-2021-SPACE-01-23: New space transportation solutions and services

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries</p>

	not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.
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Expected Outcome: Projects are expected to contribute to all of the following outcomes:

- Contribute to EU Green Deal objective through the reduction of the environmental impact of space transportation and to be prepared for the upcoming REACH regulations, especially with respect to the use of hydrazine and its derivatives, focussing on commercial market as a driver for business growth.
- Contribute to expand commercial space transportation offer and services with new space transportation solutions. The objective is to contribute to double the accessible new space transportation service market to European industry by 2030.
- Design and performance studies as well as business cases (demonstration of economical viability).
- Matured technologies including functional and qualification test on ground.

These outcomes will contribute to enhance the sector competitiveness, in line with the Expected Impact of the destination.

Scope: There are emerging opportunities in space transportation that are not yet seized by European actors characterised by new uses of space (e.g. small satellites, larger constellations and payload recovery) new destinations (e.g. direct GEO, re-entry from LEO).

The expected proposed activities shall contribute to the maturation of enabling new technologies and subsystems (including common building blocks) in the field of green propulsion, micro launchers and associated launch facilities, kick stage, orbital propulsion and distancing, attitude and landing, re-entry solutions for space transportation including new routes up to Lunar orbit or surface.

The maturation could go up to subsystem and system level and may include one or several of the following areas:

- “low thrust” green and low cost propellant functional propulsion systems and vehicle system aspects of existing propulsion systems for use of green propellants,
- Green engine, attitude control systems (RACS), thruster, ignition, fluid control equipment, propellant tank,
- Actuation Systems and Pyrotechnic Systems, light weight structure concepts for micro launchers and re-entry vehicles,
- Smart dispenser for multi-satellites and payloads launch solutions,

- Attitude Orbital Module and re-entry module, descent and landing,
- GNC, autonomous localization and termination, modern TM/TC data handling, low-cost and modular avionics, Automated Rendezvous and Capturing Technologies, Avionics and test-bed.

Proposed developments should be a step in a new space transportation service development roadmap (reference to guidance document to be inserted) and include the business case which is driving the activities.

All the activities shall be complementary and coherent with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019.

Evolution of space and ground infrastructure for Galileo/EGNOS

Actions related to this section can be found under "Other actions"

Evolution of Copernicus services

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-41: Copernicus Climate Change Service evolution

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- The evolution of the Copernicus Climate Change Service (C3S) should ensure enhanced quality and enhanced efficiency of the current service in response respectively to policy and/or user requirements and to technological developments implementing the space regulation, but also complementing the challenges targeted by the Horizon Europe Mission on “Adaptation to climate change including societal transformation”.
- The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive through efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation. This is essential

because the service is expected to handle more and more high-volume satellite data sets and product sets.

- Furthermore, emerging space missions in the coming decade will provide new types of space observation data (being from new Sentinels or other contributing missions), which may allow the development of new products or the improvement of existing products, and which also require new algorithms and processing chains to be developed.

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

- New and innovative coupled data assimilation methods to improve the next generation of global and regional reanalyses in the climate consistency of Earth-system reanalysis datasets
- Underpinning science in predictability and new and innovative multi-model product generation to improve the realism (including representation of extremes and teleconnection patterns) of the current generation of climate prediction models.

With an integrated modelling approach, the integration of new observational data becomes a driver for further enhancement and improved realism of the already existing production chains, assimilation systems and coupled models. The development of advanced processing and modelling techniques, as well as the exploitation of new sources of data, will be targeted to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users. The projects shall take into account the existing service and clearly define to what extent service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new products.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to 1 project will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

HORIZON-CL4-2021-SPACE-01-42: Copernicus Atmosphere Monitoring Service evolution

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- The evolution of the Copernicus Atmosphere Monitoring Service (CAMS) should ensure enhanced quality and enhanced efficiency of the current service in response respectively to policy and/or user requirements and to technological developments.
- The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive through efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation and implementing Big Data & analytics modern solutions. This is essential because the service is expected to handle more and more high-volume satellite data sets and product sets.
- Furthermore, emerging space missions in the coming decade will provide new types of space observation data (being from new Sentinels or other contributing missions), which may allow the development of new products or the improvement of existing products, and which also may require new algorithms and processing chains to be developed.

Scope: The R&I, which needs to be addressed to tackle the above expected outcomes are:

- New and innovative data assimilation of atmospheric composition satellite observations to expand the use of satellite data streams in the Copernicus Atmosphere Monitoring Service (CAMS) operational global and regional production systems, to improve the quality of the CAMS global and regional reactive gases and aerosol information products (analyses, forecasts and reanalyses) and to deliver near-real-time observations-based emissions of reactive gases and aerosol at the global scale

- New methods for quantifying uncertainties for atmospheric CAMS composition products in the context of decision-making as well as of environmental policies development and implementation to be directly useful for the users of the product.

With an integrated modelling approach, the integration of new observational data becomes a driver for further enhancement and improved realism of the already existing production chains, assimilation systems and coupled models. The development of advanced processing and modelling techniques, as well as the exploitation of new sources of data, will be targeted to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users. The projects shall take into account the existing service and clearly define to what extent the service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new products.

The main output of the project shall be tools and methodologies that can be readily transferred for improving aerosol representation in CAMS operational global and regional systems. The proposal shall develop activities that will improve the quality of the aerosol variables in the CAMS global and regional analyses, forecasts and reanalyses, as well as of the CAMS solar radiation products.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to 1 project will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

HORIZON-CL4-2021-SPACE-01-43: Copernicus Security and Emergency Services evolution

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

Expected Outcome: Project results are expected to contribute to [all/some] of the following expected outcomes:

- Emergency and security applications have similar requirements in terms of resolution, detection capabilities and timely access to data, one of the main challenges being the provision of critical information as fast and accurate as possible.

- Emergency and security applications are also highly user-driven and need to provide data that often needs to be fused with non-space data to be easily integrated along end-user intelligence supply chains and to bring added value at operational level.
- With a well-established community of users in both domains, Copernicus will firstly need to ensure continuity in service provision.
- Secondly, services will also have to evolve to handle an increasing volume of satellite data while keeping underlying technology up-to-date and include new paradigms in data fusion, processing and automation to match users increasing expectations in added-value, easiness of access and visualisation.

Scope: The R&I, which needs to be addressed to tackle the above expected outcomes will investigate new and innovative methods and technologies to enhance the current services performance. Specifically timeliness access to data, the need to reduce the gap between user needs and service provision, new paradigms in data fusion, automation and inclusion of wider sets of complementary, non-EO data to demonstrate the viability of extending services to a broader range of users (relevant authorities from European to local levels) and to better monitor security and emergency threats at regional or local level.

Upstream in the space segment, emerging EO missions in the coming decade will provide new types of space data (being new Sentinels or other contributing missions), which also require new algorithms and processing chains to be developed. Both the development of advanced processing and modelling techniques will be targeted and the exploitation of new sources of data, to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users.

On data fusion, vast amounts of EO-data are now being available for applications in the security and disaster domains. Identification of complementary data sets, development and testing of new and innovative ways to efficiently integrate them in emergency and security applications will be used to generate added-value and new intelligence. Non-EO data could include in-situ observations, meteorological data, data from aerial platforms, social media or crowd-sourcing, as well as information generated from other Copernicus services.

Proposers are advised to exploit all possible synergies with other security specific actions funded under the work programme of Cluster 3 “Civil security for society”.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to 1 project will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

HORIZON-CL4-2021-SPACE-01-44: Copernicus evolution for cross-services thematic domains

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- The objectives of the Copernicus programme are to reinforce its capacity (both space and services) to keep protecting the environment and the citizens by responding to emerging policies while maintaining the key factors that made its strength.
- This action collects lines of activities useful to design and support the definition and development of new thematic and policy-related domains leveraging the different core services.
- The thematic and policy approach is part of the Copernicus evolution and is based on the identification of new policy(ies) or user need(s) and the corresponding observational and information gaps.
- This approach should be the starting point for integrating and expanding the Copernicus services portfolio from the user perspective and to better handle the evolution of the programme according to the Commission objectives.
- This approach should take into consideration synergies, complementarities and harmonisation across core services.

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

- Copernicus-based solutions for an integrated monitoring and forecasting system for the Arctic regions
- Copernicus-based solutions for an integrated approach to support the production of many UN Sustainable Development Goals indicators such as long-time series to monitor atmosphere composition and air quality, the health of ocean and in land waters, and regular mapping of land use ready to be used (in terms of content, compliance to methodology of calculation, consistency of time series, accuracy and veracity, formats and standards)

This approach shall foster the exploitation of space EO capabilities to close observation gaps in combination with ground-based infrastructure and innovative processing/modelling techniques. The proposed developments shall be modular and scalable and proposals shall provide a proof-of-concept or a prototype that can be easily integrated into the service(s).

Proposals shall include the development of tools to support end users in their decision-making activities (e.g. decision support systems, assessments, decision processes) using Copernicus data and products and meeting the need for timely and quality long-term global/regional information. Proposals shall have the objective to increase the capabilities and capacity of end users to use Copernicus data and products. The involved end-users shall provide feedback to the proposed tools on product efficiency, data access, new measurement needs, new applied research topics, societal benefits, and other factors if necessary.

Depending on the selected area(s), user communities shall be involved in the proposal. They are mainly public authorities from national to local scale, operators of protected areas that need to be monitored, administration in charge of planning and services in charge of law enforcement. The community ranges from the fisheries or maritime authorities to land managers, foresters and park managers, environmental agencies but also administration of cultural site or universities. It also includes many of the actors that have to comply with environmental rules from the business sector.

New digital tools shall be considered and innovative solutions shall be proposed for an optimal exploitation of the data, improved processing and distribution chains, e.g. cloud and HPC computing, distributed computing, Artificial Intelligence, machine learning, ensemble modelling, model coupling & nesting, software as-a-service.

The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer from research to operations shall receive full attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making freely available, for re-using and exploiting the results (including IPR) to the entities implementing the EU Copernicus programme. The software shall be open licensed in order to use, copy, study, and change it in any way. The activities of

the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

Proposals shall address only one of the R&I areas.

To ensure a balanced portfolio, grants will be awarded to proposals not only in order of ranking but at least also to those projects that are the highest ranked so as to cover all the R&I areas, provided that the proposals attain all threshold.

Up to 2 projects will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

Innovative space capabilities: SSA, Govsatcom, Quantum

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-61: GOVSATCOM Technology Development and implementation of system innovative features

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the</p>

	<p>following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>
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Expected Outcome: Projects are expected to contribute to the following outcomes:

Contribute to the preparation of the GOVSATCOM component of the EU Space Programme.
In particular:

- i) Research on the advanced technologies, and realisation of prototypes up to TRL level 4/5 (technology development/demonstration; product developments up to flight readiness) needed to ensure the security of the future space segment of satellite governmental communications, including technologies required for increased European non-dependence/critical technologies.
- ii) Development of innovative features for the evolution of the GOVSATCOM ground and space segments.

Scope: R&I for the maturation of EU GOVSATCOM supporting technologies including e.g.:

- Flexible phased array antennas providing multi-beam and beam-forming capabilities, digital signal processing, software-defined Radio, and related flexible payloads programmable in response to changing needs such as capacity flexibility and geographic coverage and distribution of traffic,
- Ground segment technologies for satellite control systems, mission planning systems, user terminals including multi-satellite and multi-band support and for beam hopping, and in support to the different security levels required by the different EU GOVSATCOM services and user categories.
- Implementation of future ground and space segment components, including innovative features of the EU GOVSATCOM planned and future space segment, such as LEO and Arctic constellations, optical space communications for data relay, planned satellite-based air-traffic management solutions, future implementation for 5G and of Very High Throughput Satellites.

- e.g.: advanced coding, modulation and cryptography, key management solutions, anti-jamming, secure TM/TC including secure hosted payload solutions, inter-satellite links (including data relay solutions), optical feeder link.

HORIZON-CL4-2021-SPACE-01-62: Quantum technologies for space gravimetry

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

Expected Outcome:

- Support the EU space policy and the green deal by paving the way for the deployment of a future EU Earth observation mission making use of quantum gravimetry
- Ensure EU non-dependence for the development of capacities leading to the availability of quantum space gravimetry
- Enhance the TRL of all (critical) components necessary to build quantum gravimetry for space

These outcomes will contribute to securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector competitiveness, in line with the Expected Impact of the destination.

The proposals are expected to answer all the expected outcomes.

Scope: The scope of this topic is the development of EU technologies and components for a space quantum gravimeter or gradiometer (including hybrid sensors, relying both on quantum and classical technologies) and the realisation of an Engineering Qualification Model.

The enhancement of the TRL for cold atom interferometry (including Bose-Einstein Condensates) components is a key objective of this call. The scope also covers the development of software simulation tools to analyse the different mission concepts linked to these sensors or processing and analysis of the sensor data. This also includes the development and/or use of testbeds such as the Einstein elevator or any other system used to recreate or simulate the space environment (including airborne testing) to test quantum gravimeters technology components.

The priority for this topic is the development of the technology leading to the deployment of a gravimeter pathfinder mission based on cold atom interferometry.

The proposals should answer the whole scope of this topic.

As the actions under this topic are related to the Union strategic assets, interests, autonomy and security, for the protection of the essential security interest of the Union and its Member States, in particular with regard to the need to preserve the integrity and resilience of the Union systems, as well as the autonomy of the industrial basis on which they rely, the participation to them shall be limited to those legal entities established in the EU Member States and effectively controlled by Member States or nationals of Member States.

Space entrepreneurship ecosystem (including "New Space" and start-ups) and skills

Actions under this section can also be found under 'Other Actions'.

Targeted and strategic actions supporting the EU space sector

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-81: Space technologies for European non-dependence and competitiveness

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

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

- To reduce the dependence on critical technologies and capabilities from outside Europe for future space applications;
- To develop or regain in the mid-term the European capacity to operate independently in space;
- To enhance the technical capabilities and overall competitiveness of European space industry vendors on the worldwide market;
- To open new competition opportunities for European manufacturers by reducing dependency on export restricted technologies that are of strategic importance to future European space efforts;
- To improve the overall European space technology landscape and complement and/or create synergy with activities of European and national either in the space or non-space fields.

Scope: Research and innovation to mature critical space technologies selected from the JTF List of Actions 2021-2023 shall be implemented in 2021 as the following technology lines.

- **[JTF-2021/23-10] - RF components**
- **[JTF-2021/23-13] - Passive & RF Passive components**
- **[JTF-2021/23-14] - A - Discrete power devices**
- **[JTF-2021/23-17] - Very high energy ion accelerators for component, shielding and radiobiology characterization**
- **[JTF-2021/23-22] - D - Widespread applications of metallic lead (Pb)**

Context information and high-level requirements, including description of scope, initial and target TRLs, and, where applicable, references and information of related activities, are provided in the JTF List of Actions 2021-2023. Accordingly, a technical guidance document, based on the JTF List of Actions 2021-2023, is published on the Funding & Tenders Portal outlining all relevant information to the selected actions.

Activities shall be complementary and create synergy with other European activities in the same domain either in the space or non-space fields. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries, including technology research institutes and academia. Commercial assessment should be conducted of the supply chain space technology, identification of critical dependencies and, if applicable, the business plan for commercialization, including time to market indication, of the developed product and/or full range of recurring products.

With a view to achieving the non-dependence objective, applicants must

- Describe the technologies and/or technology processes to be used and show that they are free of any legal export restrictions or limitations, such as those established in the International Traffic in Arms Regulations (ITAR), Export Administration regulation (EAR) such as EAR99 or equivalent instruments applicable in other jurisdictions;
- Set up a suitable technology development process aiming at avoiding export restrictions of non-EU states and assess vulnerabilities of the supply chain.

HORIZON-CL4-2021-SPACE-01-82: Space science - scientific exploitation of space data

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Produce new scientific knowledge relying on new and existing but under-exploited data from space missions
- Allow academics, scientists, researchers and engineers to collaborate with international partners
- Foster international lab-to-lab cooperation in the field of quantum in space

Scope: The exploitation of all acquired and available data provided by space missions in their operative, post-operative or data exploitation phase and by space-related ground based investigations, in particular, scientific disciplines (e.g. engineering, physics, astronomy) underlying any component of the EU Space programme (e.g. satellite communication, including quantum communication, navigation & positioning, Earth observation, Space Weather, Near Earth Objects, Space Surveillance and Tracking).

Activities should target primarily European and European-led space science and exploration missions or internationally-led missions where the participation of European partners provides demonstrated added-value in terms of technological development and scientific output. New space applications, ideas, knowledge and techniques need more than ever highly trained researchers ready to propagate them, enrich them and make them effective. Strategies to support that aim shall promote advanced tools that facilitate building new high added value open datasets.

The actions shall stimulate cooperation between academia, research establishments and industry and enable circulation of ideas, the exchange of concepts, transfer of knowledge, learning of new skills and the dissemination of techniques.

International cooperation is encouraged in particular with countries active in space exploration and space science. More specifically, international cooperation on quantum applications aims at developing international lab-to-lab cooperation between

- EU and Australia
- EU and Japan

on quantum applications in space, in particular quantum communication and scientific exploitation of quantum gravimetry data

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2021 - APPLICATIONS

HORIZON-CL4-2021-SPACE-02

Conditions for the Call

Indicative budget(s)¹¹¹

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹¹²	Number of projects expected to be funded
HORIZON-CL4-2021-SPACE-02-51	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-02-52	RIA	Around N/A	Not relevant	

¹¹¹ 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 2021 and 2022.

¹¹² Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2021-SPACE-02-53	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-SPACE-02-54	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Development of applications from the EU space programme components

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-02-51: EGNSS and Copernicus applications fostering the European Green deal

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

<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Development of innovative EGNSS and Copernicus based solutions that contribute to the implementation of the European Green deal¹¹³. These solutions can play a major role in the transformation of the EU's economy into a climate-neutral economy by 2050, environmental protection, biodiversity etc.
- Uptake of Copernicus services and/or Galileo's specific features and differentiators in areas such as zero-pollution, EU methane strategy, clean and renewable energy and circular economy; sustainable and smart mobility; building and renovation, and digital/precision farming supporting the farm to fork strategy.

Scope: Proposals shall focus on the development of innovative EGNSS and Copernicus applications that support the Green Deal objectives and its related policies and may be submitted in any of the following areas:

- **A zero-pollution ambition for a toxic-free environment:** EGNSS and/or Copernicus based solutions which contribute to CO₂ reductions and a toxic free environment, through better monitoring and preventing pollution from the air, water, soil and consumer products.
- **Supplying clean, affordable and secure energy:** EGNSS and/or Copernicus based solutions which support the supply of clean, affordable and secure renewable energy. EGNSS and/or Copernicus based solutions which limit the damage from fires, floods or other natural hazards.
- **Accelerating the shift to sustainable and smart mobility:** EGNSS and/or Copernicus based solutions which enable or contribute to the development of new sustainable mobility services and which reduce congestion, emissions and pollution especially in urban areas, while keeping costs at an effective level. Examples of emerging applications include: automated and connected multimodal transport, mobility as a service, autonomous driving, IoT solutions for efficient mobility, road maintenance, air quality monitoring and forecasting.
- **Building and renovating in an energy and resource efficient way:** EGNSS and/or Copernicus based solutions, which contribute to the digitisation, smart monitoring and tracking of building and renovation processes. Examples of emerging applications include EGNSS based augmented or mixed reality for construction, special mapping solutions for making digital twins of buildings, utilities and infrastructure using Building Information Modelling (BIM), location-based applications for governmental processes,

¹¹³ COM (2019) 640 of 11 December 2019

e.g. energy labelling of buildings leveraging the authentication feature, sensors for smart monitoring, drones with thermal camera to detect water and thermal leaks.

- **From “Farm to Fork”: a fair, healthy and environmentally friendly food system:** EGNSS and/or Copernicus based solutions which provide for food security and traceability across the entire supply chain. Precision or digital EGNSS farming solutions which reduce significantly the use of chemical pesticides and fertilisers. Innovative EGNSS and/or Copernicus based tools that support the digitisation of post-2020 Common Agricultural Policy or other agri-environmental policies.

The developed solutions for all five areas shall leverage the Copernicus data and core services products and/or EGNSS differentiators, e.g. High Accuracy Service, authentication features or Galileo Open Service with multi-frequency capability. The developed solutions may integrate technologies like IoT, big data, artificial intelligence, drones, 5G, augmented/mixed reality etc.

Developed applications shall have a clearly defined commercial potential and should respond to well identified user needs. The expected final TRL of the solution developed shall be between 7-9.

Proposals should deliver new innovative applications, with commercial impact and a clear market uptake.

For proposals under this topic:

- Participation of industry, in particular SMEs and midcaps, is encouraged;
- Participation of entities based in countries without a space tradition is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-CL4-2021-SPACE-02-52: EGNSS applications for Safety and Crisis management

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

<i>project</i>	different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Development of innovative EGNSS based solutions contributing to a resilient and more stable Europe that protects citizens.
- Development of innovative EGNSS solutions addressing safety concerns, to support the implementation of EU policy priorities relating to the safety of citizens, improved disaster risk management, improved border protection, better security and resilience of infrastructure and vital societal functions, cybersecurity, crisis management and fighting crime and terrorism more effectively.
- Development of innovative EGNSS based solutions complementing the products delivered by the Emergency Management and Security Services of Copernicus.

Scope: Proposals may be submitted in any of the following areas:

- **Improved emergency disaster risk management and societal resiliences.** EGNSS solutions for critical services related to preparedness, response, recovery and mitigation of emergencies and disasters, introducing synergies between satellite navigation, earth observation and communications. EGNSS solutions that leverage Search and Rescue service for resilience and management in crisis situations, following a disaster where conventional means, e.g. telecommunications, are no longer existent. Further promising areas include mapping and high accuracy navigation for response and recovery, more intelligent and accurate distress beacons for Safe and Rescue, drone operations for disaster response, GNSS-based earthquake early warning system, Helicopter Emergency Medical Services.
- **Timing and synchronisation applications** focussing on emerging network synchronisation needs of critical infrastructures (electricity, telecommunications, financial etc.) in terms of accuracy and robustness, while reducing EU dependency from other GNSS. Proposals may e.g. focus on increasing receiver resilience to interference, increasing resilience and reliability in the reception of GNSS signals, tighter and more accurate time/phase requirements, timing precise synchronisation between financial platforms, Critical Assets Monitoring and Data Center resistance against spoofing data; telecommunication networks' operation; small cell synchronisation and 5G; Energy distribution and Phasor Measurement Units for smart grids. Links to the timing metrology infrastructure may be included, where relevant.

Proposals shall exploit EGNSS differentiators such as Galileo Open Service multifrequency, Galileo High Accuracy Service (HAS), Galileo Open Service Navigation Message Authentication (OS-NMA), Galileo Signal Authentication Service and Galileo Search and Rescue Service (SAR) for the development of new innovative applications.

Developed applications shall have a clearly defined commercial potential and should respond to user needs. The expected final TRL of the solution developed shall be between 7-9.

Proposals should deliver new innovative applications, with commercial impact and a clear market uptake. The use of other space components such as Copernicus is recommended. In particular, the use of Copernicus Emergency Management and Security services is highly encouraged. The developed solutions may integrate other non-space technologies like IoT, big data, artificial intelligence, drones, 5G, augmented/mixed reality etc.

For proposals under this topic:

- Participation of industry, in particular SMEs and midcaps, is encouraged;
- Participation of entities based in countries without a space tradition is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-CL4-2021-SPACE-02-53: EGNSS applications for the Digital Age

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Foster the adoption of EGNSS in mass markets
- Create applications that will make the best use of EGNSS innovative features such as better multipath resistance, authentication etc.
- Contribute to the competitiveness of the European GNSS industry in the area of mobile applications, with special focus on the innovative role of SMEs and midcaps, and non-space countries.
- maximise public benefits by supporting the development of EGNSS applications that will address major societal challenges in focus areas such as health, citizen safety, mobility and the sharing economy.

Scope: Proposals may be submitted in any of the following areas:

- **Internet of Things:** Within Internet of Things solutions, there is a clear trade-off in terms of accuracy and battery life that prevents users to rely on GNSS in any situation. EGNSS solutions should demonstrate how power reduction techniques can effectively deliver GNSS-level accuracy in IoT devices and develop IoT solutions able to demonstrate the EGNSS compositeness in the IoT domain, to be used in application fields such as food geo traceability, blockchain and Artificial Intelligence
- **Mobile solutions.** Development of new EGNSS enabled solutions which exploit the EGNSS differentiators such as High Accuracy Service and authentication feature,s or which leverage the availability of GNSS raw measurements in smartphones.
- **mHealth-solutions for silver economy, robotics.** With the ageing population growing fast in EU, governments will be increasingly challenged in meeting the needs of older people in a cost-effective manner. EGNSS can support the silver economy by satisfying the specific needs of elderly and disabled persons. The innovations brought by EGNSS - together with technologies such as robotics or enhanced home automation – should be exploited to develop innovative solutions.
- **Artificial intelligence- Big Data, Geo-tagging, optimisation for multiple sensors.** Advances in AI will improve the capabilities of applications and services, providing improved experiences to all users.AI-enabled machine learning can be used to improve the GNSS data processing to provide even greater performances thanks to the optimization of multiple sensors. Proposals shall explore synergies between EGNSS and Artificial intelligence, also in the frame of applications relaying on big data and geo-tagging techniques. Synergies with earth observation data can be also exploited.
- **Cybersecurity- solutions that are stimulating privacy, security of location data, exploiting synergies with quantum.** In a digitalised world, privacy and cybersecurity are of utmost importance for individuals who are increasingly relying on digital applications to perform day-to-day task and activities. EGNSS solutions shall enhance the security of location-based applications. Additionally, synergies with quantum can be leveraged as well.

- **Sharing economy- solutions for logistics, mobility services, goods and food.** Sharing economy covers a great variety of sectors and is rapidly emerging across Europe. Within this trend, GNSS is a key technology for all service models requiring geographic information. EGNSS solutions in the field of logistics, mobility services, and food industry should be developed that capitalise on enhanced accuracy and the innovative features provided by EGNSS.
- **Sports and fitness- smart wearables.** Wearables represent the beginning of the separation between smartphones and end users, as an increasing number of smartphone services and apps are now accessible via new interfaces (smartwatches, fitness trackers, smart glasses, clothing, etc.). Currently, wearables are mostly used for fitness, health and entertainment. Proposals should ensure the use of EGNSS innovative features and differentiators in the smart wearables domain, integrating also other non-space technologies.

Synergies with other space components and other non-space technologies are applicable to this topic.

Developed applications shall have a clearly defined commercial potential and should respond to user needs. The expected final TRL of the solution developed shall be between 7-9.

Proposals should deliver new innovative applications, with commercial impact and a clear market uptake. The use of other space components such as Copernicus is highly encouraged. The developed solutions may integrate other non-space technologies like IoT, big data, artificial intelligence, drones, 5G, augmented/mixed reality etc.

For proposals under this topic:

- Participation of industry, in particular SMEs and midcaps, is encouraged;
- Participation of entities based in countries without a space tradition is encouraged;
- Involvement of post-graduate researchers (engineers, scientists, and others) is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.
- Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-CL4-2021-SPACE-02-54: Innovative EGNSS receivers, chipsets and antennas

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>Legal entities have to be authorised by the Security Accreditation Board in line with Decision EU 1104/2011/EU.</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p>

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

- Development of EGNSS receivers, chipsets and antennae in non-mature markets with a low EGNSS penetration (e.g. critical infrastructure), in long lead term markets (e.g. rail), or the development of prototype receivers or chipsets which leverage new EGNSS services.

Scope: Proposals shall target the development of EGNSS receivers, chipsets and antennae in non-mature markets with a low EGNSS penetration (e.g. critical infrastructure), focus on long lead term markets (e.g. Rail), or the development of prototype receivers or chipsets which leverage new EGNSS services.

Proposals shall build on the operational implementation of current differentiators such as OS-NMA, HAS and triple frequency to ensure the successful development and leverage new and enhanced Galileo services introduced by its evolutions. In parallel, the commercial

implementation of new differentiators as CAS (Commercial Authentication Service) or ARAIM (Advanced Receiver Autonomous Integrity Monitoring) should be explored.

The development of emerging, disruptive technologies should continue to be fostered in new areas of applications such as advanced robotics, automation, artificial intelligence, machine learning, safety and liability critical transport etc.

While at application level synergies between EGNSS & Copernicus or GovSatCom are more evident, the synergies between other space systems on user technology should be increased.

Moreover, company consortia should be accompanied after the project duration to scale-up their business and create synergies with other business partners together with other entrepreneurship initiatives. The participation of start-ups, SMEs and midcaps is encouraged.

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2022

HORIZON-CL4-2022-SPACE-01

Conditions for the Call

Indicative budget(s)¹¹⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹¹⁵	Number of projects expected to be funded
HORIZON-CL4-2022-SPACE-01-11	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-12	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-21	RIA	Around N/A	Not relevant	

¹¹⁴ 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 2021 and 2022.

¹¹⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2022-SPACE-01-41	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-42	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-43	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-61	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-62	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-72	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-81	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-01-82	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Foster competitiveness of space systems

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-11: Future space ecosystems: on-orbit operations, preparation of demonstrator mission

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p>

Expected Outcome: The expected outcomes of this topic is to prepare a European pioneering, orbital demonstration mission for On-Orbit Servicing (OOS) in 2025-2026 period that will demonstrate and showcase European know-how, open new business opportunities & foster international cooperation, deliver a long-lasting impact in the future space ecosystem.

Projects should in particular contribute to prepare and showcase a future space ecosystem fostering the EU's space sector competitiveness, as stated in the expected impact of this destination. Further building on modularity and enabling on-orbit servicing, assembly, manufacturing and recycling, and facilitate a smooth transition between the short-term market needs and future commercial possibilities while respecting the protection of the in-space ecosystem.

Scope: R&I on phase B2-D mission study¹¹⁶ and target-oriented technology maturation (TRL 6) to prepare an orbital demonstration mission integrating robotic and autonomy technologies and technical building blocks applying and enhancing the European Operations Framework for OOS. Technology maturation should aim at risk reduction of the intended pioneering orbital demonstration mission as well as at raise of confidence on OOS applications in general. The designed satellite platform should be compatible to a functional upgrade in Phase

¹¹⁶ according to ECSS-M-ST-10C

D enabled by functional satellite modules (Orbital Replaceable Units to deliver new/enhanced functionality), developed outside this topic and able to be connected to the platform using a pre-existing standard interface¹¹⁷ (*plug-and-play* concept).

Work done on Space Robotics including the European Operations Framework (EOF) in Horizon 2020, and especially on the phase A-B1 mission studies to be launched in 2020, should be exploited where possible. The EOF guidelines¹¹⁸ should be applied to and enhanced by the orbital demonstration mission.

Further reference is given in a technical guidance document¹¹⁹. Technical documents of the previous studies in the H2020 Strategic Research Cluster *Space Robotics Technologies*¹²⁰ are available on the PERASPERA website.

HORIZON-CL4-2022-SPACE-01-12: Very low-power electric propulsion systems

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p>

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

- To strengthen, in the mid-term, the European capacity to compete in the worldwide arena of electric propulsion satellites and missions in order to be in time and adapted to market.

¹¹⁷ Multi-functional interface for OOS applications providing at least transfer of mechanical loads, power and data (e.g. HOTDOCK, iSSI or SIROM)

¹¹⁸ www.h2020-peraspera.eu

¹¹⁹ Published on the EU funding and tenders portal (<https://ec.europa.eu/info/funding-tenders/opportunities/portal>)

¹²⁰ www.h2020-peraspera.eu

- To develop the Incremental Technology Electric Propulsion (EP) System up to system demonstration in a space environment and ready for its qualification
- Matured technologies up to TRL 6-7 and beyond towards operational products

Scope: R&I to advance the very low power class (up to 300 W), which serving disruptive and emerging markets for satellite applications. The requirements vary a lot depending on the type of spacecraft (from CubeSat to small satellites), depending on the on-board power available, the orbit of operations, and the application type. A wider portfolio of solutions needs to be investigated, only limited by the potential size of the demand. The core objective is to strengthen the maturity of technologies towards operational products (TRL 6-7). The aim is to achieve qualification at EP system level. This means that the required components shall be developed in close cooperation with the thruster developers, thus guaranteeing optimal interfaces, optimal performance and reduction of iteration costs. The components developers will be stimulated to take advantage of the different technologies and Generic Building Blocks developments achieved through Horizon 2020 to support the different types of EP applications and thrusters.

The scope of activities includes, where appropriate, the preparation of IOD/IOV demonstration(s).

Reinforce EU capacity to access and use space

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-21: Multi sites flexible industrial platform and standardised technology for improving interoperability of EU access to space ground facilities

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and</p>

	<p>SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>
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Expected Outcome: Projects are expected to contribute all the following outcomes:

- Contribution to the overall objective of launch cost/price reduction by 50% by 2030, for the benefit of EU Space programmes implementation and towards reinforcing EU's independent capacity to access to space.
- Improve cost efficiency of existing European test, production and space launch facilities.
- Feasibility study of an industrial platform (perimeter, technologies, costs), including cost benefit assessment, of key technologies in representative conditions.
- Matured technologies up to TRL 5/6 standardized technology for improving cost efficiency, interoperability of access to space ground facilities in EU, ground assets portability to speed-up deployments.

These outcomes will contribute to enhance EU strategic autonomy and sector competitiveness, in line with the Expected Impact of the destination.

Scope: Cost reduction and improving flexibility of European launch systems are the main challenges in order to foster European industry competitiveness on the global market.

Europe needs to improve the cost efficiency of the ground facilities and of launch systems production and operations for the strategic launchers essential for the implementation of EU space programme. It could benefit from the industry 4.0 transformational wave, which has the

potential to exploit digitalisation and advanced data management for lowering the cost of low production rate facilities and further improving quality.

The activities address technologies maturation applicable to strategic launch systems able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030.

The maturation will go up to TRL5/6.

The activities will address one or several of the following listed domains under a) and/or b):

- a. Multi sites flexible industrial platform:
 - o Feasibility study and maturation of key technologies in representative conditions of a flexible platform as a tool for existing and future European space launcher products, to enable a cost-efficient approach including existing Manufacturing Assembly Integration and Testing capabilities as design constraints, to increase economical robustness against variable production rates in the rocket industry and to optimise transfer from existing to new launcher productions
 - o To explore, including from other industrial sectors, the use of a value-stream mapping (including the material- and information flow) in the field of Design to Manufacturing, Integration, Maintenance and Operation capabilities including improvements based on advanced data management and Artificial Intelligence. Maturation of technologies, including for reusable parts of the launch systems.
- b. Develop standardised and cost effective innovative technologies to improve cost efficiency of existing Test and Launch facilities, their interoperability and compatibility/attractiveness for new users, including one or several of the following domains :
 - o modern data handling, data processing,
 - o eco-friendly technologies,
 - o automation and innovation controls,
 - o mobile telemetry systems, mobile payload preparation facilities,
 - o vacuum simulation test facilities,
 - o security and safety

All the activities shall be complementary and coherent with the ESA on-going or future activities, in particular those decided at the last ESA Ministerial held in November 2019 (reference to guidance document to be inserted)..

Proposals under this topic may be subject to security scrutiny if they could potentially lead to security-sensitive results that should be classified (see guide for classification available at the Funding & Tenders Portal).

Evolution of space and ground infrastructure for Galileo/EGNOS

Actions under this section can be found under 'Other Actions'

Evolution of services of the EU space programme components Galileo, EGNOS and Copernicus

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-41: Copernicus Marine Environment Monitoring Service evolution

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

The evolution of the Copernicus Marine Environment Monitoring Service (CMEMS) should ensure enhanced quality and enhanced efficiency of the current services in response respectively to policy and/or user requirements and to technological developments implementing the space regulation, but also complementing the challenges targeted by the Horizon Europe Mission: “Healthy oceans, seas, coastal and inland waters” and can also contribute to the initiative United Nations Decade of Ocean Science for Sustainable Development.

- The baseline is to preserve continuity of what has been achieved while keeping the services modern and attractive through efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation. This is essential because the services are expected to handle more and more high-volume satellite data sets and product sets.
- Furthermore, emerging space missions in the coming decade will provide new types of space observation data (being from new Sentinels or other contributing missions), which

will allow the development of new products or the improvement of existing products, and which also will require new algorithms and processing chains to be developed

Scope: The main scope of this R&I is the development of a new and innovative models for biogeochemistry and marine ecosystems monitoring. These models will be used to prepare Copernicus-based solutions for different policies areas and for the challenges related to pollution. Some specific domains will be the exploitation of the dynamics of the biological component of the ocean in terms of ‘fauna and flora’, how this marine living component behaves in relation to the ocean physics (temperature, currents, sediments), its biochemistry composition (in particular the plankton-to-fish links), climate change and the man-made pressures (e.g. transport, pollution, fisheries, etc.).

With an integrated modelling approach, the integration of new observational data becomes a driver for further enhancement and improved realism of the already existing production chains, assimilation systems and coupled models. The development of advanced processing and modelling techniques, as well as the exploitation of new sources of data, will be targeted to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users. The projects shall take into account the existing service and clearly define to what extent service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new products.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7 at least) demonstrating the feasibility of the integration in the existing core service. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

New technological tools shall be considered and innovative solutions shall be proposed for better data exploitation, processing and distribution, e.g. move to cloud and HPC computing, distributed computing, Artificial Intelligence and machine learning (e.g. for automatic feature recognition), ensemble modelling, model coupling & nesting, software as-a-service.

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to 1 project will be funded

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

HORIZON-CL4-2022-SPACE-01-42: Copernicus Anthropogenic CO₂ Emissions Monitoring & Verification Support (MVS) capacity

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

To enable the EU to move towards a low-carbon economy and implement its commitments under the Paris Agreement, a binding target to cut emissions in the EU by at least 40% below 1990 levels by 2030 was set and the European Commission President von der Leyen committed to deepen this target to at least 55% reduction by 2030. This was further consolidated with the release of the Commission's European Green Deal on the 11th of December 2019, setting the targets for the European environment, economy and society to reach zero net emissions of greenhouse gases in 2050, outlining all needed technological and societal transformations that are aiming at combining prosperity and sustainability.

The expected outcome is the continuation of the set up of the new Copernicus element for the monitoring of anthropogenic CO₂ emissions. Designing and building the prototype systems for this anthropogenic CO₂ emissions Monitoring and Verification Support (CO₂MVS) capacity was already started within the H2020 programme and it is foreseen to run a pre-operational service under Copernicus from 2023 onwards. The CO₂MVS capacity is first of its kind, and worldwide unique and will require further new specific research activities to achieve its goals. This element will support all the Parties' commitments to reduce CO₂ emissions as agreed in the Paris Agreement.

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes:

- New and innovative methodologies to improve the definition of the correlations between emissions of co-emitted species (CO₂, NO₂, CO, CH₄) in support of CO₂ fossil fuel emission estimation
- New and innovative methods to better use of auxiliary observations such as ¹⁴C (radiocarbon), SIF (Solar Induced Fluorescence), and APO (Atmospheric Potential Oxygen) to separate anthropogenic CO₂ emissions from the natural variability of CO₂

The main objective is to perform R&D activities identified as priorities for the Copernicus CO2MVS capacity as identified by the European Commission's CO2 monitoring Task Force¹²¹.

The activities shall support the further development of the foreseen European operational monitoring support capacity for fossil fuel CO₂ emissions. These activities shall complement or follow-up on the activities within the H2020-funded CO2 Human Emissions (CHE)¹²² project and the Prototype system for a Copernicus CO₂ service (CoCO2) project.

The activities, as described in the Guidance document, shall address a series of scientific and critical system design issues, which were defined following outcomes of the CHE project and based on recommendations from the CO₂ monitoring Task Force.

More generally, this action shall support the development of an integrated support capacity, enabling European experts to collectively share their knowledge and join forces on the multiple fronts required to develop such a system with operational capabilities.

The activities shall fulfil the technological and scientific requirements for the development of this European operational capacity, to further improve the prototype system to better meet user requirements and to exploit synergies with other Copernicus services.

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7 at least) demonstrating the feasibility of the integration in the existing core service.. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to 1 project will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

HORIZON-CL4-2022-SPACE-01-43: Copernicus Land Monitoring Service evolution

Specific conditions

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¹²²

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

The evolution of the Copernicus Land Monitoring Service (CLMS) should ensure enhanced quality and enhanced efficiency of the current services in response respectively to policy and/or user requirements and to technological developments.

- The baseline is to preserve continuity of what has been achieved while keeping the services modern and attractive through efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation. This is essential because the services are expected to handle more and more high-volume satellite data sets and product sets.
- Furthermore, emerging space missions in the coming decade will provide new types of space observation data (being new Sentinels or other contributing missions), which may allow the development of new products or the improvement of existing products, and which also may require new algorithms and processing chains to be developed.

Scope: Since 2013, CLMS has developed core products for the monitoring of natural resources and the assessment of land cover and land use changes, including land cover conditions. At European level, land cover mapping is carried out on a regular basis, every 6 years for CORINE and every 3 years for the thematic ‘High Resolution Layers’ (HRL). The local component dealing with land cover mapping on specific areas like riparian areas, urban zones and natural 2000 sites, is following the same approach with a 6 years cycle but at very high resolution. At Global level, an annual land cover mapping has been proposed since 2015 at mid resolution, the evolution to high resolution is also envisaged.

Vegetation, Inland Water and Cryosphere conditions are also monitored but on a regular basis, mainly ten-daily basis at mid-resolution for the Global and European levels.

These mapping and monitoring approaches were partly conditioned by the availability of satellite data. The deployment of the full Earth Observation capacities of Copernicus and the complementarities between the instruments, including outside Copernicus environment, allows to rethink of the approach including for providing a better answer to the policy needs.

The R&I has the main scope to develop new and innovative methods to combine and explore data with different spatial and temporal characteristics using automatic processing for land cover and land cover status change assessment. A more dynamic approach (e.g. annual overviews or early warning or alert systems) and the integration of various sensors will enhance the development of specific automatic processing approaches for real and near real time data processing to respond to emerging European policy needs.

With an integrated modelling approach, the integration of new observational data becomes a driver for further enhancement and improved realism of the already existing production chains, assimilation systems and coupled models. The development of advanced processing (also including AI and HPC) and modelling techniques, as well as the exploitation of new sources of data, will be targeted to create new products or significantly improve the quality and performances of existing elements-components for the benefit of users.

The project shall take into account the existing service and clearly define to what extent the service will be improved with new elements or products, including the use of enhanced models, algorithms, tools and techniques to generate new product(s).

Proposals are expected to provide tangible results (new or improved products or service elements) for the Copernicus service within the period 2021-2027. The proposed research and development shall be modular and scalable. The project shall provide a proof-of-concept or a prototype (e.g. system element targeting TRL7 at least) demonstrating the feasibility of the integration in the existing core service. The activities of the project should be connected with relevant actions within the Group on Earth Observation and outcomes and results of the project should be promoted at international level through the Global Earth Observation System of Systems (GEOSS).

Additionally, the transfer of research results to possible operations shall receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future, including the conditions for making available, for re-using and exploiting the results (including IPR) by the entities implementing the EU Copernicus programme. Software shall be open licensed.

Up to maximum 1 project will be funded.

Proposers are advised to consult information on the Copernicus programme in general at <https://www.copernicus.eu/en> and further details on the topic in the Guidance document.

Innovative space capabilities: SSA, Govsatcom, Quantum

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-61: GOVSATCOM Service developments and demonstrations

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.</p>

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

- Consolidation of security-related services, demonstrations in a user context and in particular for civilian users and synergies with the services provided by the other components of the Space Regulation (e. g. services for civil protection with Copernicus images).

- This topic address service developments in support to all High Level User Needs, including direct involvement of users and with emphasis on civilian users. This should include Pooling & Sharing demonstrations, in particular on services enabled by new technology developments such as ground segment, RPAS, optical communications or Internet of Things. Service development should include an element of awareness building and outreach.

HORIZON-CL4-2022-SPACE-01-62: Space Weather

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome: Commonly occurring space weather events (SWE) have the potential to affect the performance of critical space and ground infrastructure by disrupting operations and communications in multiple sectors of society. In addition, “extreme SWE” could have devastating societal and economic consequences with potential costs for disruptions and damages estimated in tens or even hundreds of billions of Euros. Space weather technological research for new precursor services: the worldwide goal of space weather activities should be to monitor and forecast SWE just like terrestrial weather. However, direct physical simulation is currently not achievable for an operational Sun to Earth system, due in part to the lack of measurements and to the complexity of the involved processes, as well as different timescales involved. Current space weather models are generally not capable of forecasting events over several days. A longer forecasting horizon would require access to data from new observation infrastructure coupled with new and improved modelling capabilities. Research and innovation activities shall address application domains that may include space as well as terrestrial infrastructure. Proposals shall include architectural concepts of possible European space weather services in relation to the application domains addressed and they shall demonstrate complementarity to Space Weather services developed through the Space Situational Awareness component of the EU Space Programme.

- Prepare Europe for a full exploitation of space weather data by a renewed effort on modelling and forecasting using currently available data.
- Improve scientific understanding of the origin and evolution of space weather phenomena.

- Improving SWE restitution and prediction capabilities using artificial intelligence / deep learning techniques.

Space weather exploratory payloads studies & predevelopments

- Acceleration innovation of enabling technologies (maturing, prototyping, on ground tests)
- Identified and matured concepts up to TRL 3-4

Matured technologies up to TRL 5-6, prototyping and on ground tests

Scope:

- New modelling and forecasting techniques capable of improving the restitution quality and extending the time horizon of a future space weather forecasting capability to several days.
- Proposals shall address the development of modelling capabilities and/or the delivery of prototype services able to interpret a broad range of observations of the Sun's corona and magnetic field, of the Sun-Earth interplanetary space and of the Earth magneto/iono/thermo-sphere coupling relying on existing observation capacities.
- Training of models using deep-learning techniques based on existing large aggregated databases from space measurements.
- Inventory of potential early indicators of extreme space weather events.
- Complementary and coherent activities with the ESA on-going or future activities in particular those decided at the last ESA Ministerial held in November 2019.
- Maturation of technologies, building blocks, tools and processes that will address SWE
- On ground demonstration tests
- Complementary and coherent activities with existing space weather services with a significant involvement of European scientific institutions and stakeholders.

Space entrepreneurship ecosystems (including "New Space" and start-ups) and skills

Actions under this section can also be found under 'Other Actions'.

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-72: Education and skills for the EU space sector

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- A structured overview of the educational offer in the EU, including continuing education for the EU space sector.
- Socio-economic analysis of the space-oriented student population and identification of gaps/shortcomings and excellences across the EU-27 and Associated Countries.
- Identification of the needs for education and skills in the EU space sector and of potential new educational knowledge answering emerging and future needs
- Assessment of the adequacy between curricula and sector needs;
- Actions for the promotion of space jobs and career in Bachelor and Master courses
- Creation of educational material for jobs related to Earth observation and Positioning Navigation and Timing, in particular downstream.
- In relation to the expected impact, these outcomes will contribute to foster the EU space sector competitiveness by enhancing the adequacy between the needs of the sector and the qualification of the workforce and reinforce EU capacity to develop products and services with a higher level of autonomy.

Scope: Competitiveness and innovation of the EU space sector depends on the availability of high educational standards and skilled professionals across a range of qualifications and the possibility for these professionals to upgrade and update their skills. This is also in the interest of the research and innovation community where the quality of the results and the impact of EU-funded research is a precursor of the future space sector. The EU also plays a role in the aligning with educational degrees to provide more opportunities and promote mobility of professionals and researchers across countries and sectors.

The scope of this action encompasses:

- The analysis of the main curricula and courses available and existing educational standards across the EU27 at bachelor, master and post-graduate levels as well as continuing education (training and staff qualification / certification). The study should

provide an overview of the ‘supply’ of space-oriented education and of the ‘demand’, a quantitative analysis of the ‘stocks & flows’ of students at the different levels eventually employed in the space sector at large (academia, government agencies, upstream industry, downstream industry) including socio-economic aspects (e.g. gender, educational background, family income, parents’ education, residence geography, etc.), and a comparative analysis of the cost/time to achieve a degree. This should be supported by extensive, in-depth quantitative and fact-based time-series evidence and encompass EU27 and Associated Countries.

- The analysis of the skills required and reskilling needs of the R&I and the industrial community (across the entire supply chain, ranging from upstream space to downstream space) will be performed and structured, presumably along existing educational modules (e.g. electrical, mechanical, telecommunication, system engineering, physics, psychology, medicine). The analysis should engage both industry and educational institutions, as well as not be limited to technical / scientific, engineering disciplines skills needed in an innovating world such ability to work in a diverse multidisciplinary team, to communicate efficiently, to create new activities and businesses, etc. An assessment of the number of professionals needed in the different sectors will be produced, based on fact-based and in-depth quantitative analysis of the demographics across EU-27, the current/projected enrolment rate into space-oriented disciplines, the success rate, etc. This will also include an exploratory look at future skills which the space sector might need in the future. The analysis should take into consideration results stemming from existing activities funded under Horizon 2020, e.g. the EO4GEO project (<http://www.eo4geo.eu/>) and the PERSEUS project <https://cordis.europa.eu/project/id/640211>
- The analysis of the match between needs and offer across the whole of EU-27 will be analysed and recommendations made to ensure improved adequacy between the needs and the offer in the coming years. For this purpose, a benchmarking of the careers opportunities for space-oriented graduates issued of different universities across EU-27 and Associated Countries (e.g. time to first employment, average salary after 3-5-7 years, etc.) will be performed. An assessment of the net inflows/outflows within EU27 and Associated Countries and with non-EU countries will be carried out.
- In particular, the co-operation between academia and industry in the field of PhD will be assessed and measures to promote the research experience of the academic personnel proposed.
- The use of continuous learning “in-company” and “out-of-company” supported by the new digital technologies with guaranteed quality e.g. Massive Online Open Course (MOOC) will be assessed and promoted.
- Action will be undertaken for the promotion of the space sector jobs and careers (in particular where there is a strong demand for qualified workforce) and information about

the different curricula and disciplines of interest for such careers in Bachelor and Master courses.

- Action will be undertaken for the creation of course modules in relation to the 2 EU flagship constellations Copernicus and Galileo for jobs related earth observation and PNT, in particular for the downstream sector.

Up to 1 project will be funded.

Targeted and strategic actions supporting the EU space sector

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-81: Space technologies for European non-dependence and competitiveness

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the</p>

	protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- To reduce the dependence on critical technologies and capabilities from outside Europe for future space applications;
- To develop or regain in the mid-term the European capacity to operate independently in space;
- To enhance the technical capabilities and overall competitiveness of European space industry vendors on the worldwide market;
- To open new competition opportunities for European manufacturers by reducing dependency on export restricted technologies that are of strategic importance to future European space efforts;
- To improve the overall European space technology landscape and complement and/or create synergy with activities of European and national either in the space or non-space fields.

Scope: Research and innovation to mature critical space technologies selected from the EU-EDA-ESA joint task force list of Actions 2021-2023 shall be implemented as the following technology lines.

- **[JTF-2021/23-9] - A - High performance, cost effective multi - junction solar cells for space applications**
- **[JTF-2021/23-11] - Space qualified RF GaN components and demonstrators**
- **[JTF-2021/23-14] - B - Integrated circuits for power applications**
- **[JTF-2021/23-15] - High challenges for PCBs and SMT (Surface Mount Technologies)**
- **[JTF-2021/23-29] - Thermal insulation systems based on aerogels for Space**

Context information and high-level requirements, including description of scope, initial and target TRLs, and, where applicable, references and information of related activities, are provided in the JTF List of Actions 2021-2023. Accordingly, a technical guidance document,

based on the JTF List of Actions 2021-2023, is published on the Funding & Tenders Portal outlining all relevant information to the selected actions.

Activities shall be complementary and create synergy with other European activities in the same domain either in the space or non-space fields. Technological spin in and/or bilateral collaborations should be enhanced between European non-space and space industries, including technology research institutes and academia.

With a view to achieving the non-dependence objective, applicants must

- Describe the technologies and/or technology processes to be used and show that they are free of any legal export restrictions or limitations, such as those established in the International Traffic in Arms Regulations (ITAR), Export Administration regulation (EAR) such as EAR99 or equivalent instruments applicable in other jurisdictions;
- Set up a suitable technology development process aiming at avoiding export restrictions of non-EU states and assess vulnerabilities of the supply chain.

HORIZON-CL4-2022-SPACE-01-82: Space science and exploration technologies

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Enable breakthroughs in technologies and scientific instrumentation for space science and exploration missions.
- Validation of novel human spaceflight and robotic space technologies and instrumentation through analogue tests.
- Increased collaboration of scientific, engineering and industrial teams both within and outside Europe across different domains.

Scope: The development of instrumentation and technologies enabling space science and exploration missions may address technology development associated with future space science and exploration missions, including robotic exploration technologies, early stage scientific instrumentation and technologies for space resources utilisation and space

observatories. The development of new and innovative approaches, such as the use of Cubesats and other small space platforms, including planetary entry probe, or the use of Commercial off-the-shelf (COTS) components is encouraged as long as it contributes to the implementation of space science and exploration missions with significant scientific outputs.

Advances are expected in support to on-site activities such as entry, descent and landing, planetary navigation, sample collection and processing or in-situ analysis.

The proposed activities should target primarily European and European-led space science and exploration missions or internationally-led missions where the participation of European partners provides demonstrated added-value in terms of technological development and scientific output. Activities on robotic exploration technologies shall where relevant build upon results of Horizon 2020 projects on space robotic technologies¹²³.

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2022 - APPLICATIONS

HORIZON-CL4-2022-SPACE-02

Conditions for the Call

Indicative budget(s)¹²⁴

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²⁵	Number of projects expected to be funded
HORIZON-CL4-2022-SPACE-02-51	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-02-52	RIA	Around N/A	Not relevant	

¹²³ <https://www.h2020-peraspera.eu>

¹²⁴ 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 2021 and 2022.

¹²⁵ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

HORIZON-CL4-2022-SPACE-02-53	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-02-54	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-02-55	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-SPACE-02-56	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Development of applications from the EU space programme components

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-02-51: EGNSS applications for Smart mobility

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

<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Development of EGNSS based safety-and liability-critical applications in long lead time market segments such as aviation, maritime, rail, road transportation and multi modal domains.
- EGNSS response to the increasing mobility demands and emerging transport solutions, such as those enabled by autonomous or unmanned platforms.
- The action aims at fostering the EGNSS market uptake in transport. Applications shall demonstrate the advantage of Galileo and EGNOS specific features and differentiators for their use in smart and green mobility, and shall contribute to a resource efficient, safe, climate and environmentally friendly transport, that will be for the benefit of citizens, the economy and society.

Scope: Proposals may be submitted in any of the transport areas or propose a multi-mode approach:

- **Aviation:** EGNSS solutions for modernising and improving air operations and traffic management technologies, addressing Communication, Positioning, Navigation and Timing, as well as Surveillance, targeting new navigation operations powered by EGNSS (e.g. 4D, GBAS DFMC, surveillance), increased airport efficiency (e.g. leveraging SWIM), critical airport infrastructure management (e.g. synchronization, monitoring, surveying), polar routes surveillance against space weather events and facilitating integration of drones in the airspace (drone operations, U-Space services leveraging EGNSS and Earth observation data, dynamic maps), as well as new entrants in the airspace, such as high altitude flights.
- **Maritime:** EGNSS solutions that reduce emissions in shipping and increase efficiency of operations (e.g. ports operations and logistics, intelligent routing), safety (e.g. fisheries, navigation at sea, coastal and inland waters, surveillance and accident investigation, search and rescue at sea), and resilience, and drive the modernization of the sector (e.g. Internet of boats, automation, GNSS contribution to marine communication networks).
- **Rail:** EGNSS for cheaper, smarter, higher performance, safer and emission-efficient solutions (e.g. contributing to the deployment of EGNSS based signaling and its inclusion into the evolution of the European Train Control System (ETCS), efficiency-

focused innovations enabling cost savings, capacity increase and automation, infrastructure management, dangerous goods transport, autonomous trains). EGNSS based train localization for critical applications as well as the use of Copernicus for infrastructure related operations shall ensure that the EU railways sector keeps pace with rest of the world, where the adoption of space-based services already started.

- **Road:** EGNSS solutions for regulated markets that reduce traffic, optimise fuel consumption, lower emissions, and foster cheaper, smarter, safer and greener transportation. EGNSS solutions to support the development of connected and autonomous driving, next generation vehicles and novel user equipments, new capacities for vehicles, e.g.intelligent speed adaptation, and the use of integrated space data for road safety and environment, such as monitorization of road infrastructures (e.g. land slides and bridge infrastructure), and AI-based cyber threat mitigation (e.g. localization spoofing attacks). EGNSS solutions that valorize of EGNSS regulations such as the eCall system (e.g. GNSS Tolling for passengers cars, congestion charging in Smart Cities, eParking, traffic information), or of the Smart Tachograph in commercial vehicles (e.g. custom control and cross-border enforcement, cabotage and freight activities).

Proposals should be built on the exploitation of the distinguishing features of EGNOS and Galileo.

The action focuses on the development of close to market EGNSS transport applications and mobility services through the realisation of large scale demonstration and implementation projects.

Developed applications shall have a clearly defined commercial potential and should respond to user needs. The expected final TRL of the solution developed shall be between 7-9.

Proposals should deliver new innovative applications, with commercial impact and a clear market uptake. The use of other space components such as Copernicus is highly encouraged. The developed solutions may integrate other non-space technologies like IoT, big data, artificial intelligence, drones, 5G, augmented/mixed reality etc.

For proposals under this topic:

- Participation of industry, in particular SMEs and midcaps, is encouraged;
- Participation of entities based in countries without a space tradition is encouraged
- Involvement of post-graduate researchers (engineers, scientists, and others) is also encouraged, for example through professional work experience or through fellowships/scholarships when applicable;
- A Business Plan and evidence of user engagement shall be compulsory and shall be provided as part of the proposal, to demonstrate the user need and sustainability of the project.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-CL4-2022-SPACE-02-52: Public sector as Galileo and/or Copernicus user

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Stimulate the public sector in Europe to use space downstream products, involving SMEs and midcaps.
- Support to public stakeholders through specific funding tools, to develop, via pre-commercial procurement (PCP) innovative EGNSS and/or Copernicus based solutions
- Encourage the public sector to be the “first customer” for innovative space based applications and contribute to speeding up the public sector modernisation.
- Enable public procurers to collectively implement PCPs in order to close the gap between supply and demand for innovative solutions that require e.g. precise location (from EGNOS/Galileo), spatial data and earth monitoring capabilities (from Copernicus).
- Bring radical improvements to the quality and efficiency of public services by encouraging the development and validation of breakthrough space-based solutions
- Prepare Galileo and/or Copernicus-based solutions for an integrated approach to support national public authorities to concretely uptake Galileo and/or Copernicus products and use them within their mandate and regulatory tasks and specifically helping them integrating Galileo and/or Copernicus in their regulatory systems, operational procedures and decision-making.
- Decrease of the prices of EGNSS and Copernicus based products/services, a smart use of the procurement budget to remove supplier lock-in and obtain more open, standardized solutions, shorter time-to-market facilitating the access of SMEs to the procurement market and increased exploitation of IPRs and R&D results.

Scope: This topic is open to proposals for PCP actions in all areas of public sector interest requiring innovative solutions in different market segments that exploit space data. It is open both to proposals requiring improvements mainly based on one specific downstream space technology (e.g. Galileo, Copernicus, GovaSatCom), as well as to proposals requiring end-to-end solutions that need combinations of different space components.

The topic is dedicated for public administration to procure research and experimental development that exploits space data and services (e.g. Galileo and/or Copernicus) and that meets their needs. In addition, the proposals should build on the procurement needs of the participating organizations, supporting the EGNSS, Galileo and/or Copernicus market take-up across Europe and demonstrating a sustainability of solutions beyond the lifespan of the proposed project. Promising areas of activities are the following, however, the choice of market segment and application is left to the proposer:

- EGNSS and/or Copernicus for mobility as a service, cooperative ITS, public transport, smart cities and air quality monitoring and forecasting,
- Integration of EGNSS into U-Space concept for drones,
- Monitoring of infrastructure with EGNSS and/or Copernicus (rail, road, critical infrastructure)
- Copernicus and/or EGNSS for crisis emergency management, including related to extreme events (i.e. storm surges, coastal floods)
- Copernicus and/or EGNSS for security applications
- Copernicus and/or EGNSS for sustainable development, climate change adaptation, mitigation and resilience services
- Copernicus and/or EGNSS for coastal area monitoring and modelling, also related to coastal planning and operations.

Activities covered shall reinforce the national policy frameworks and mobilise substantial additional national budgets, as well as awareness raising, technical assistance and/or capacity building to other procurers beyond the project to mainstream PCP implementation and to remove obstacles for introducing the innovative solutions to be procured into the market.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-CL4-2022-SPACE-02-53: Innovative governmental EGNSS receiver, chipsets and antennae (PRS)

Specific conditions	
<i>Expected EU</i>	The EU estimates that an EU contribution of around EUR N/A million

<i>contribution per project</i>	would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%
<i>Eligibility conditions</i>	<p>The conditions are described in General Annex B. The following exceptions apply:</p> <p>In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.</p> <p>Legal entities have to be authorised by the Security Accreditation Board in line with Decision EU 1104/2011/EU.</p> <p>Some activities, resulting from this topic, may involve using classified background and/or producing of security sensitive results (EUCI and SEN). Please refer to the related provisions in section B Security — EU classified and sensitive information of the General Annexes.</p>

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

- The development of PRS receivers, chipsets and antennas for the first generation of Galileo.
- Stimulate the downstream PRS market uptake via the delivery of accredited PRS equipment, promote the integration of secure services in other space components, such as GovSatCom and Copernicus, and to increase and disseminate knowledge and support cross border EU cooperation between Member States and Associated Countries with whom a PRS Agreement in accordance with Decision 1104/2011/EU has been concluded, so as to deliver concrete solutions for EU strategic challenges such as safety and the competitiveness of the European industry.

Scope: The action shall focus on the development of innovative technologies in the following areas, considering that each equipment will have to fulfill the EU security requirements

- **PRS space grade receivers.** The development of PRS space grade receivers on board the satellites, to ensure a higher protection against interferences of GNSS services and the service provider infrastructure, and maintain the availability and continuity of the service. This topic is focused on civilian use.
- **Secondary Channel:** The development of user equipment and technology, required to provide secure ground communication between secure PRS items of the user segment. The knowledge gathered under this action is of benefit also to other Space Programmes.

Any development of equipment shall have a clear target of intended application, shall be justified by its commercial potential and shall respond to the user needs. The expected final Technology readiness level (TRL) of the solution developed shall be between 8 and 9 again with the view that these EU made in solutions shall support competitiveness and company's growth.

HORIZON-CL4-2022-SPACE-02-54: Copernicus downstream applications and the European Data Economy

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Europe needs to strengthen its position as provider of products and services based on data, enabling new market opportunities. The EU is promoting the use and uptake of Copernicus, a leading European data provider, as a driver of innovation for the European Data Economy.
- Actions under this Topic will contribute to increase the integration and uptake of Copernicus into the economy, and/or to solve societal challenges.
- The integration of Copernicus data assets with data contributed by other vertical domains into sizeable and scalable applications enabled by modern ICT technologies will greatly enhance Copernicus downstream market. Likewise, many vertical domains (such as, for example, agriculture, food security, health, energy, natural resources, environmental monitoring, insurances, tourism, security etc...) will benefit from the use of Copernicus.

Scope: Actions under this Topic will bring to market new or improved applications, products and services by exploiting Copernicus data assets and services products.

To achieve the objectives described above, the project are required to adopt state-of-the-art ICT technologies (such as, for example, Big Data and AI technologies in their wider declinations), and make use of existing European data infrastructures, such as Copernicus DIAS platforms, European open data portals, and industrial data platforms.

The technical solutions to be adopted shall be user-friendly and work at the scale of the large quantities of data involved. They shall be adopted to contribute to the digitization challenges of the European industry by opening up innovative business avenues and to support societal challenges.

Copernicus data and services products will be at the core of the projects' data value chains and integration activates needed to fulfil the industrial and users requirements that will drive the actions. Whenever relevant, the link with European satellite positioning/navigation/timing technologies should be exploited.

Proposers are required to present initial qualifying items of their business plan in the proposal, which will then have to be fully developed as part of the project's exploitation plan.

HORIZON-CL4-2022-SPACE-02-55: Large-scale Copernicus data uptake with AI and HPC

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Copernicus is producing increasingly large data volumes that require specific Big Data technologies and Artificial Intelligence (AI) methods to analyse it and manage it. The adoption of Big Data and AI technologies in the space industry represents a significant opportunity to innovate, following industrial requirements to better respond to well identified user needs.
- Moreover, the data infrastructures offering archiving and distribution services for Earth Observation data, including Copernicus, are often data silos that offer today limited discoverability, querying and linking possibilities. The full exploitation of the archives

and data stores require specialized Artificial Intelligence technologies, Linked Open Data paradigms and semantic archives able to scale to the full archives data volumes. Enhancing those cloud infrastructures with technological paradigms that are now typical of other data intensive domains (such as multimedia), will contribute to facilitate the development of new products and services with earth observation data at their core, and connect earth observation data to European Data Spaces.

- Copernicus data are part of the European Data Economy and its value chains. As such, this call is promoting the collaboration of ICT actors, both from industry and academia, with the earth observation/space stakeholders and Copernicus users.

Scope: To address the expected outcomes described above, proposers are requested to respond to one of the following challenges:

1. Develop new and innovative products and services designed by industrial and user requirements, having Copernicus data assets and services products at their core, and scaling up to the increased data volumes of Copernicus' archives, by solving the technological challenges related to Artificial Intelligence, HPC, Big Data management, and the integration with distributed data sources from other industrial domains.
2. Develop new, enabling, scalable, operational solutions and technologies to improve capabilities and performance of the Copernicus value chain and supporting infrastructure: from access and discovery of data and information (required to fully integrate Copernicus data archives, including into the wider web of data and connect to European Data Spaces, in a machine to machine modality) to integration with other data sources and analysis to delivery and applications. Proposals can address individual elements of the value chain or the value chain as a whole.

For both challenges proposers are requested to provide quantitative measures of the progress beyond the state of the art.

To ensure a balanced portfolio covering the two challenges described above, grants will be awarded to applications not only in order of ranking but at least also to one project that is the highest ranked within each area, provided that the applications attain all thresholds.

HORIZON-CL4-2022-SPACE-02-56: Designing space-based downstream applications with international partners

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

<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome: Projects with international cooperation partner countries are expected to contribute to the three following high level outcomes:

1. The use of EGNSS and sharing of expertise with public and/or private entities to introduce EU-space based applications/solutions leveraging their innovative, unique features, in particular Galileo differentiators (authentication, high accuracy) and EU know-how.
2. The use of Copernicus data, to jointly develop algorithms, services and/or products, which serve local user needs and/or enhance the Copernicus global product quality.
3. The combined use of EGNSS and Copernicus to develop innovative downstream applications combining positioning navigation and timing with Earth observation services

Projects will also contribute to the following objectives:

- Lead to new or improved products, processes or services – using EU space technologies (Copernicus, EGNSS as enabler - that are capable of generating a marketable solution for the local market
- Maximize and spread the benefits of space-based applications and solutions enabled by EGNSS and/or by Copernicus, to leverage downstream space excellence in particular of SMEs and universities, to facilitate investments and to foster market uptake.
- Creation of partnership with non-EU entities towards commercialization, to trigger public and/or private investment from Europe and beyond to take advantage of market opportunities in Europe or local markets;
- Capacity building and awareness raising, around EGNSS and Copernicus based applications and solutions, particularly in the regulated domains.

Scope: Proposals can target one or more of the three expected outcomes. Proposal can also include the use of other space based or non-space based assets and services, with a preference given to those based in the EU and in the international cooperation partner countries applying to these topics.

The actions should focus on technical developments of EU-space based applications/solutions, dissemination, awareness-raising, as well as provide opportunities for the creation business-oriented partnerships of European industry with international partners. By doing so the action should be achieving a critical mass of space based-application success stories, demonstrating the advantages and differentiators of EU space based solutions and services and making it an attractive option for public authorities, private industries and private investors in Europe and elsewhere.

Cooperation with international partners, either public or private, is key to:

- promoting the uptake of satellite navigation , position and timing, to enable non EU countries to benefit from the advanced and unique features offered by EGNOS and Galileo, particularly in transport and regulated domains.
- promoting the uptake of Copernicus globally, exploiting possibilities for integrating in-situ, space data and information technologies. Building the Copernicus full, free and open data policy, the Commission seeks to facilitate access to Copernicus data and information for interested international partners. Administrative cooperation arrangements on Copernicus data access and Earth observation data exchange have already been signed with several countries; the United States, Australia, Ukraine, Chile, Colombia, Serbia, African Union, India and Brazil. Discussions towards similar cooperation have been started with other countries and regions (including United Nations Agencies and Asia-Pacific countries).

Tasks may include joint calibration and validation activities or integration of local in-situ systems to enhance the quality of data and service products. It is important to exploit the added value of integration of EO observation technologies (both satellite, airborne and ground based) with positioning ones, and ICT (e.g. cloud computing) from international partner countries through the development of applications, and encourage their insertion into the market.

Technology promotion activities can include incentive schemes in the form of financial support to third parties, that will promote the uptake of space downstream applications across Europe and globally.

For proposals under this topic:

- Proposals dealing with EGNSS are encouraged to involve the relevant players on the European side whenever relevant (e.g. EASA, ESSP or Member States' ANSPs for EGNOS Safety of Life service to aviation, EMSA, ERA for other transports). Participation of industry, in particular SMEs, is encouraged;
- When dealing with Copernicus based applications, participation of at least one partner from a country that has signed a Copernicus Cooperation Arrangement is required; Proposals are encouraged to use the Copernicus Data and Information Access Services (DIAS), or other existing data access solutions instead of setting up their own download and processing infrastructure. They are also encouraged to integrate third-party data (including in-situ data) and envisage data assimilation into models and products made available on the Copernicus platform of the Copernicus services. Participation of partners involved in international GEO initiatives is encouraged. Participation of industry, in particular SMEs, is encouraged;
- Involvement of public authorities is encouraged, whenever relevant;

- Involvement of post-graduate scientists, engineers and researchers is encouraged, if relevant for the project.

DRAFT

DESTINATION 6 – A HUMAN-CENTRED AND ETHICAL DEVELOPMENT OF DIGITAL AND INDUSTRIAL TECHNOLOGIES

This destination will directly support the following Key Strategic Orientations, as outlined in the Strategic Plan:

- **KSO D, Creating a more resilient, inclusive and democratic European society**, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions

Proposals for topics under this Destination should set out a credible pathway contributing to the following expected impact:

- **A human-centred and ethical development of digital and industrial technologies**, through a two-way engagement in the development of technologies, empowering end-users and workers, and supporting social innovation.

As Europe takes the lead in the green and digital transitions, workers, regions, and societies are faced with extremely fast transformations, and will be differently affected by these changes. The rapid adoption of new technologies offers an immense potential for improved standards of living, safer mobility, better healthcare, new jobs, or the personalisation of public services. At the same time, it presents risks such as skills mismatches, digital divides, customer lock-in, or serious breaches of security or privacy.

As Europe sets off on its path to recovery towards a greener, digital and more resilient economy and society, the need to improve and adapt skills, knowledge and competences becomes all the more important. Developments in digital and enabling technologies have the potential to enhance social inclusion, can inform up-skilling training programmes and ensure a two-way engagement with society with regard to developing technologies.

The issue of trust has become central in the use of technologies, following revelations about the exploitation of personal data, large-scale cybersecurity and data breaches, and growing awareness of online disinformation. For AI technologies, trust requires in particular improving transparency (explainability, expected levels of performance). For the Internet, increasing trust requires new tools and services to ensure that GDPR is a reality for end-users.

It is also an opportunity for Europe to re-gain presence on the consumer electronics market, by developing new interactive applications in various sectors with solutions meeting European values and requirements in terms of privacy and security. The COVID-19 crisis has also shown how important distance and innovative learning is for society.

Actions under this Destination will support EU objectives of inclusiveness, by supporting a human-centred approach to technology development that is aligned with European social and ethical values, as well as sustainability. These actions will further contribute to addressing the challenges faced by European industry and support the creation of sustainable, high-quality

jobs by targeting skills mismatches, the need to empower workers, and ethical considerations relating to technological progress.

Actions should devote particular attention to openness of the solutions and results, and transparency of the research process. To ensure trustworthiness, public awareness and support, wide adoption by user communities for the benefit of society, actions should promote the highest standards of transparency and openness. Actions should ensure that the processes and outcomes of research and innovation align with the needs, values and expectations of society, in line with Responsible Research and Innovation.

This Destination is structured into the following headings, which group topics together with similar outcomes to address a common challenge:

- Leadership in AI based on trust

The objective of this heading is to ensure autonomy for Europe in AI, leading the way in research, development and deployment of world-class technologies that are beneficial to humans individually, organisationally and societally, and that adheres to European values, such as the principles reflected in our fundamental rights and environmental sustainability. Technologies need to be developed that industries and citizens will trust, so and that they can will be applied in a wide range of applications and industrial sectors. Trustworthy AI is particularly key in applications such as (but not limited to) healthcare or in diverse critical infrastructures such as energy and transportation.

Some topics of this heading are under the co-programmed Partnership ‘AI, Data and Robotics’.

Proposals are encouraged to link with relevant European Institute of Innovation and Technology (EIT) and its Knowledge and Innovation Communities (KICs), in particular the EIT Digital.

EIT Digital plays role in shaping technologies and innovations that work for people. At least two of its focus areas, Digital Wellbeing and Digital Cities, address directly topics such as ethical artificial intelligence, predictive analytics or augmented and virtual reality that are relevant to this areas. The solutions will benefit from the increasing will of citizens to participate in the sharing economy. EIT Digital, through projects with cities for example, improves engagement and inclusiveness of the citizens and of the visitors by increasingly organising and exposing data, especially in real time and along with analytics and machine learning. Augmented and virtual reality of the cities are another facet of exposing or simulating city data from the past, present or future to the benefit of citizens.

- An Internet of Trust

The issue of trust in the internet has become central, following revelations about the exploitation of personal data, large-scale cybersecurity and data breaches, and growing awareness of online disinformation. A 2019 survey¹²⁶

shows that half of global internet users are more concerned about their online privacy compared to a year previously. Distrust in the Internet is causing people to change the way they behave online, for example by disclosing less personal information. Users also express an increasing level of distrust of social media platforms.

The objective of this heading is to develop a trustworthy digital environment, built on a more resilient, sustainable, and decentralised internet architecture, to empower end-users with more control over their data and their digital identity, and to enable new social and business models respecting European values.

- eXtended Reality (XR)

Due to its low presence in the consumer electronics industry, Europe is increasingly dependent on external providers in this area. This raises concerns about its digital sovereignty in crucial domains such as digital interaction services that are being adopted by a growing number of European users and industries. The COVID-19 crisis has shown how important distance and innovative learning is for society, our children, their parents and their teachers, maintaining social and educational links under challenging circumstances. Emerging technologies such as virtual reality, eXtended Reality or immersive environments provide numerous opportunities for personalised, innovative, efficient and inclusive learning, for learners of all ages, gender and condition

The objective of this heading is to gain industrial leadership in eXtended Reality technologies and immersive environments, while ensuring the European values of privacy, ethics and inclusiveness. It also aims to support the digital transformation of education through these technologies in particular.

- Systemic approaches to make the most of the technologies within society and industry.

This heading promotes various systemic approaches to encourage creativity and make the most of the technologies developed elsewhere within society and industry. They include testing ideas in local communities; support for IP, standardisation and industry-academia exchanges; art-driven design; and assessments of complex socio-economic systems. These are complemented by support for a network of National Contact Points (NCPs), with a special emphasis on engaging with new actors.

Activities beyond R&I investments will be needed to realise the expected impacts: testing, experimentation, demonstration, and support for take-up using the capacities, infrastructures, and European Digital Innovation Hubs made available under the Digital Europe Programme; further development of skills and competencies via the European Institute of Innovation and Technology, in particular EIT Digital and EIT Manufacturing; upscaling of trainings via the

¹²⁶

European Social Fund +; use of financial instruments under the InvestEU Fund for further commercialisation of R&I outcomes; and links to the thematic smart specialisation platform on industrial modernisation

Expected impact

Proposals for topics under this Destination should set out a credible pathway to contributing to a **human-centred and ethical development of digital and industrial technologies**, and more specifically to one or several of the following impacts:

- Increased inclusiveness, by supporting a human-centred approach to technology development that is aligned with European social and ethical values, as well as sustainability;
- Sustainable, high-quality jobs by targeting skills mismatches, the need to empower workers, and ethical considerations relating to technological progress.[\[1\]](#) 2019 CIGI-Ipsos Global Survey on Internet Security and Trust

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

Call	Budgets (EUR million)Deadline(s)
HORIZON-CL4-2021-HUMAN-01	
HORIZON-CL4-2022-HUMAN-01	
Overall indicative budget	

Call - A HUMAN-CENTRED AND ETHICAL DEVELOPMENT OF DIGITAL AND INDUSTRIAL TECHNOLOGIES 2021

HORIZON-CL4-2021-HUMAN-01

Conditions for the Call

Indicative budget(s)¹²⁷

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹²⁸	Number of projects expected to be funded
HORIZON-CL4-2021-HUMAN-01-01	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-02	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-03	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-04	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-05	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-06	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-07	CSA	Around N/A	Not relevant	

¹²⁷ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.

The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2021 and 2022.

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

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HORIZON-CL4-2021-HUMAN-01-08	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-09	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-13	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-14	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-15	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-17	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-18	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-19	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-20	CSA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-21	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-23	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-24	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-25	IA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-26	RIA	Around N/A	Not relevant	
HORIZON-CL4-2021-HUMAN-01-27	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-16	CSA	Around N/A	Not relevant	
Overall indicative budget				

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

Leadership in AI based on trust

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-01: Verifiable robustness, energy efficiency and transparency for Trustworthy AI: Scientific excellence boosting industrial competitiveness (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- World-class transparent, explainable, accountable and trustworthy AI, based on smarter, safer, secure, resilient and accurate, robust, reliable and dependable solutions.
- Improved AI solutions aiming to meet the industrial¹²⁹ requirements in terms of safety, repeatability and robustness, resilience, security, etc.
- Greener AI.

Scope: Develop **trustworthy AI** technology, key for acceptance, to take full advantage of the huge benefits such technology can offer, and demonstrate the benefit in particular applications. This will require improvement in transparency: explainability, accountability and responsibility, safety, expected levels of technical performance (accuracy, robustness, level of ‘intelligence’ and autonomy, etc.) which are guaranteed/verifiable and with corresponding confidence levels.

Build the **next level of “intelligence” and autonomy**, essential to scale-up deployment, in solving wider set and more complex problems, adapting to new situations and context knowledge, addressing real-time performance requirements and data and energy efficiency, also for greener AI and robotics solutions. This will require a.o. integration of both learning and reasoning, causality, contextualization and knowledge discovery, hybrid semi-parametric models (combining laws of physics with observations, aka physics-informed machine learning), human-in the loop approaches for truly mixed human-AI initiatives combining the best of human and machine knowledge and capabilities.

Contribute to making AI and robotics solutions meet the requirements of Trustworthy AI, based on the respect of the ethical principles, the fundamental rights, including privacy. Ethics principles needs to be adopted from early stages of AI development and design.

In this topic, solid scientific developments will be complemented, as relevant, by tools and processes for design, testing and validation, certification (where appropriate), software engineering methodologies, as well as approaches to modularity and interoperability, aimed at real-world applications. Where appropriate proposals are encouraged to propose standardisation methods to foster AI industry, helping to create, and guarantee trustworthy and ethical AI, and in support of the EC regulatory framework.

Scientific proposals are expected to focus on advancing the state of the art in one of the major research areas below:

1. **Novel** or promising **learning** (such as unsupervised, self-supervised, representational learning capable of contextualization, transfer learning, life-long and continual learning, etc.) as well as **symbolic and hybrid** approaches. The objective is to **advance “intelligence” and autonomy of AI-based systems**, essential to scale-up deployment, in solving a wider set of more complex problems, adapting to new situations (making them “smarter”, more accurate, robust, dependable, versatile, reliable, secured, safer, etc.), and addressing real-time performance requirements, where relevant, for both

¹²⁹ Including all industries from manufacturing to service, both public and private.

robotics and non-embodied AI systems. This will include a.o. integration of both learning and reasoning, combining data-driven and knowledge-based models, causality, contextualization and knowledge discovery. Approaches can build on simulation and digital twins, or include data augmentation, knowledge modelling, federation of AI systems – including the use of distributed data – federated learning, and new AI methods ensuring scalability and re-usability. This topic also supports innovative or promising approaches addressing functional and performance guarantees.

2. **Advanced transparency in AI**, including advances in explainability, in transparency (with guaranteed/verifiable levels of performance, confidence levels, etc), investigating novel or improved approaches increasing user's understanding of AI system behaviour, and therefore increasing trust in such systems.
3. **Greener AI**, increasing data and energy efficiency. This covers research towards lighter, less data-intensive and energy-consuming models, optimized learning processes to require less input (frugal AI), or optimized models, data augmentation, synthetic data, transfer learning, one-shot learning, continuous / lifelong learning, and optimized architectures for energy-efficient hardware, framework that optimises calculations for energy reduction in big data analytics. This also build on latest results in self-configuring, low-power or energy harvesting capable sensor devices, and low power data transmission and energy reduction in big data analytics (e.g. a framework that optimises calculations, leading to decreasing use of energy, etc.).
4. Advances in **edge AI networks**, bringing intelligence near sensors, in embedded systems with limited computational, storage and communication resources, as well as the integration of advanced and adaptive sensors and perception (including multi-modal sensing and active perception, distributed sensing, etc.), but also optimising edge vs cloud AI to maximise the capabilities of the overall system (both globally and for individual users). This builds on latest hardware development, but does not cover such hardware developments.
5. **Complex systems & socially aware AI**: able to anticipate and cope with the consequences of complex network effects in large scale mixed communities of humans and AI systems interacting over various temporal and spatial scales. This includes the ability to balance requirements related to individual users and the common good and societal concerns, including sustainability, non-discrimination, equity, diversity etc.

Proposal should clearly identify its research focus. To ensure a balanced portfolio covering a broad range of AI research areas and approaches, grants will be awarded to applications not only in order of ranking but at least 4 highest ranked in the 1st area of research addressing novel or promising learning approaches, and at least 1 top ranked addressing each of the 4 other research areas, provided that the applications attain all thresholds.

Proposals should include, as appropriate, the development of tools and processes for design, testing and validation, deployment and uptake, auditing, certification (where relevant), software engineering methodologies, as well as approaches to modularity and interoperability.

To complement the impressive progress in developing individual AI algorithms and components, proposals could also address the development of scientific foundations for designing, analyzing, operating, monitoring, integrating, maintaining and extending AI systems.

In all these topics, involvement of multidisciplinary teams and transdisciplinary research will be essential. The consortia should involve world-class research labs and top scientists, joining forces to address these major scientific challenges, and they are strongly encouraged to team up with European companies (large and small) representing major industrial sectors for Europe, genuinely interested in S&T progress in these fields, and which consider adoption of AI “made in Europe” key for their competitiveness¹³⁰.

While the proposals should address scientific foundations, relevance to real-world applications should be demonstrated, in particular through use-cases used to demonstrate scientific progress.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring), and share communicable results with the European R&D community, through the AI-on-demand platform¹³¹, a public community resource, to maximise re-use of results and efficiency of funding.

Activities are expected to achieve TRL 4-6 by the end of the projects.

Proposals should foresee activities to collaborate with projects stemming from topics relevant to AI, Data and robotics, primarily in destination 3, 4 and 6, but also in other destinations and clusters (in particular Cluster 3 on cybersecurity where relevant), and share or exploit results where appropriate.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

HORIZON-CL4-2021-HUMAN-01-02: European coordination, awareness, standardisation & adoption of trustworthy European AI, Data and Robotics (CSA)

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

¹³⁰ <https://ec.europa.eu/digital-single-market/en/artificial-intelligence#Coordinated-EU-Plan-on-Artificial-Intelligence>

¹³¹ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

1.

- Efficient AI, Data and Robotics Public-Private Partnership supporting the community and the implementation of the SRIDA¹³².
- Reinforced links among initiatives in AI, data and robotics in H2020, HE, DEP, and other programmes (Networks of excellence centers, DIHs, pilots, data platforms, and other projects).
- Widespread educational and outreach programmes
- Increased adoption of AI technologies in all Member States and Associated Countries, towards elimination of gaps between Member States and Associated Countries.
- Increased adoption of trustworthy AI, data and robotics in procurement both public and private (B2B, B2C, B2G, etc.)
- Standardisation methods for trustworthy and ethical AI to foster AI, data and robotics industry, and in support of the EC regulatory framework.
 - o Online observatory of published standards and ongoing standardisation activities in AI, data and robotics worldwide.
 - o Identification of gaps and recommendations for key topics for future standardization
 - o Increased transparency of ongoing work at international and European levels through
 - o Increased participation of European stakeholders in the international standardization initiatives
 - o Recommendations on links between standardization, certification and regulation
 - o Recommendations for research and innovation activities supporting standardization

2. Continuous support to the research community via the AI-on-demand-platform¹³³, a public community resource.

¹³²

Scope: The first type of proposals will address the following aspects:

- Support to the PPP on AI, Data and Robotics to develop a strong and inclusive network bringing, academia, industry, and public and industry users, including the major industrial European sectors and all relevant stakeholders, to guarantee strong coordinated efforts toward trustworthy AI, for the economy, society and environment. The network will also include national representatives, to link to national programmes and to foster synergies and coordination between the various European, national, public and private initiatives. Such coordination of efforts in research, innovation and expertise will be important for Europe's leadership in AI. The objective is to support the community in defining and implementing the AI, data and robotics strategy for research, innovation, and deployment, and support the PPP in its coordination and support of the community in non-R&D tasks as well.
- Establish links with all relevant initiatives in AI, data and robotics in H2020, HE, DEP, and other programmes (Networks of excellence centers, DIHs, pilots, data platforms, and other projects), in view of sharing knowledge, developing synergies, and coordinate the efforts when possible. Organisation of joint events gathering projects is encouraged.

Proposals should also support and encourage the adoption of AI technologies in all Member States and Associated Countries, with particular emphasis on geographical aspect and elimination of gaps between Member States and Associated Countries

- Widespread educations and outreach programmes including public awareness and addressing acceptability and trustworthiness, informing about potentialities of AI but also ensuring that expectations are realistic to avoid backlash in the adoption. Such activities should target in particular the business community, with a particular focus on SMEs, as well as public administrators, and citizens at large.
- In addition proposals will investigate and promote the potential contribution of AI, data and robotics to social welfare and sustainability, for example as framed by the UN SDGs (sustainable development goals) and highlight the value generated by the combination of AI/data/robotics in different environments.
- Promote the adoption of trustworthy AI, data and robotics in procurement both public and private (B2B, B2C, B2G, etc.): this is crucial to foster the development of European AI industries and applications built on European data and compliant with the European regulatory framework, and to foster vast deployment of AI-based solutions.
- Proposals will also support to standardisation in view of boosting AI, data and robotics industry, helping to create, and guarantee trustworthy and ethical AI, data and robotics, and in support of the EC regulatory framework.

¹³³ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

- o Standards should guarantee that AI technology in industry brings a high level of trust and safety of operations, and that it respects fundamental values and human rights. Standards should also ensure appropriate governance of AI throughout the system lifecycle and make sure that decision systems are trustworthy by being robust, un-biased, safe and secure.
- o Developing a coherent and broadly accepted set of AI standards requires a minimum level of support to ensure that all essential players are involved and that their voices are heard and in order to disseminate information and collect essential requirements. Support is also needed to coordinate and encourage contributions to standardization activities around the world.
- o An important dimension will be to explore needs for standardisation and qualification of equipment and processes, notably the application of Artificial Intelligence to business processes

The standardisation activities should include:

- The creation of an online observatory of published standards and ongoing standardisation activities in AI, data and robotics worldwide.
- The identification of gaps and recommendations for key topics for future standardization
- Support to a mechanism for information exchange between international and European Standardization Organizations (ESOs) to increase the transparency of ongoing work at international and European levels.
- Support participation of European stakeholders in the international standardization initiatives
- Networking of all key players, collection of essential requirements for AI, data and robotics standardization and dissemination of information
- Recommendations on links between standardization, certification and regulation
- Recommendations for research and innovation activities supporting standardization

One large CSA is expected to cover all these aspects. Close cooperation is expected with the second CSA supporting the AI-on-demand platform.

The second type of proposals will be in charge of the maintenance and necessary developments and services provision for the AI-on-demand-platform¹³⁴, a public community resource, with a focus on supporting the research community. In close cooperation with the first CSA, it will further develop the platform service offering a common portal gathering relevant information, success stories, etc.

¹³⁴ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

To ensure a balanced portfolio covering the various needs and ensuring complementarity grants will be awarded to applications not only in order of ranking but the highest ranked in the 1st type of proposal, addressing all the coordination and support items listed above, and the top ranked proposal addressing the AI-on-demand platform, provided that the applications attain all thresholds.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

HORIZON-CL4-2021-HUMAN-01-03: European Network of AI Excellence Centres: towards the European AI lighthouse (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Establishing the pillars of the European AI lighthouse¹³⁵
- Reinforcing a leading unified European AI community

Advances in the major AI, data and robotics challenges hampering its deployment.

Scope: To ensure European strategic autonomy in critical technologies such as AI, data and robotics, with huge socio-economic impact, it is essential to reinforce and build on Europe's assets in such technologies, including its world-class research community, in order to stay at the forefront of technological developments.

This topic will pursue the initiative started in H2020 to develop a vibrant European network of AI excellence centres, and a vibrant AI scientific community.

As stated in the communication from the European Commission on Artificial Intelligence for Europe¹³⁶ and the coordinated action plan between the European Commission and the Member States and Associated Countries¹³⁷, while Europe has undeniable strengths with its

¹³⁵ In this section AI is taken in the broad sense and covers AI, data and robotics

¹³⁶ <https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe>

¹³⁷ https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6689

many leading research centres, efforts are scattered. Therefore joining forces will be crucial to be competitive at international level. Europe has to scale up existing research capacities and reach a critical mass through tighter networks of European AI excellence centres. The proposals should develop mechanisms to reinforce and network excellence centres in AI, bringing the best scientists from academia and industry to join forces in addressing the major AI challenges hampering its deployment, and to reinforce excellence in AI throughout Europe via a tight network of collaboration.

Such networks are expected to mobilise researchers to collaborate on key AI research challenges and to progress faster in joined efforts rather than working in silos, leading to fragmented and duplicated efforts. Such networks, are essential to reach critical mass and overcome the present fragmentation of AI research in Europe.

Proposals will bring together the best European research teams around AI to join forces and address major technical as well as sector- or societal-driven challenges in strengthening excellence, networking, multidisciplinary and developing academia-industry synergies, as relevant.

Proposals will develop Networks of excellence centres contributing to the following objective:

- Establishment of the **European AI lighthouse, a virtual center of excellence** for research, innovation and expertise, to become a world reference in AI that can attract investments and the best talents in the field. The virtual center will build on key pillars, each of them being a network of excellence centers specialising in a given topic where Europe has the potential to become a global champion. This topic will build important pillars of the European AI lighthouse in supporting networks specialising in one of the following topics:
 - o Safe and secure AI– **addressing safety and security by design**: foster the collaboration between AI with safety engineering communities, and cybersecurity communities, to develop safe-by-design and secure-by-design AI, data and robotics systems. The focus is on research, but the work should also contribute to good practices, standards and certification, complying with regulations for AI safety.

Topics to be covered include, but are not limited to:

- Technical robustness and safety, incl. methods for evaluating the resilience of systems, and standardized ways of quantifying robustness of AI
- Privacy preserving techniques and infrastructures
- Human agency and oversight in terms of system security and safety; including explainability in human-readable terms allowing to detect/prevent/mitigate/recover from harm and threats.

- o **Next Generation AI** – covering foundational research and emerging and novel approaches, with a view of improving the technical performances of AI-based systems, such as increased accuracy, robustness, verifiability, dependability, adaptability, versatility, graceful degradation, etc. Research is also expected to address functional and performance guarantees.

Aspects to be covered include, but are not limited to:

- Foundational research in artificial intelligence and machine learning including new paradigms, algorithms, architectures and novel optimization and regularization methods, hybrid AI, hybrid machine learning, data/sample –efficiency.

The networks, will mobilise the community towards achieving common goals in addressing such challenge

Composition of the Network:

- Leading researchers in AI and AI relevant technologies from major excellent research centres, bringing the best scientists across Europe, including from promising research labs. They will bring on board the necessary level of expertise and variety of disciplines and profiles to achieve their objectives, ensuring a multidisciplinary and multi-sectorial research approach, while respecting equality and diversity among the attracted talents.
- Demonstrate access to the required resources and infrastructure to support R&D, such as cloud and computing capacity, IoT, robotics equipment, support staff and engineers, where relevant, to develop prototypes, pilots, demonstrators, etc.

Activities of the Networks:

- In order to structure the activities, the proposals will focus on important scientific or technological challenges with industrial and societal relevance where Europe will make a difference, by building on strengths, or strengthening knowledge to fill gaps critical for Europe.
- Based on the identified challenges, the proposals will develop and implement common research agendas. The main vision and roadmap with targets within the projects, as well as methodology to implement and monitor progress will have to be specified in the proposal and can be further developed during the project.
- Scientific progress will have to be demonstrated through testing on application specific datasets or use-cases. By extending the benchmarking of foundational research to application specific areas, the research community will simultaneously address advancements in AI and grand societal and technological challenges.
- The proposals should define mechanisms to foster excellence throughout Europe, to increase efficiency of collaboration, including through networking and exchange programmes, and to develop a vibrant AI network in Europe.

- Each network will disseminate the latest and most advanced knowledge to all the academic and industrial AI laboratories in Europe and involving them in collaborative projects/exchange programmes. (This could involve projects defined initially or via financial support to third parties, for maximum 20% of the requested EU contribution).
- Each network will develop, where relevant, interactions with the industry, in view of triggering new scientific questions and fostering take-up of scientific advances
- Each network will develop collaboration with the relevant Digital innovation Hubs and AI start-up initiatives, to disseminate knowledge and tools, and understand their needs.
- These networks should also foster innovation and include mechanisms to exploit new ideas coming out of the network's work (for instance via incubators).
- Overall, each proposal will define mechanisms to become a virtual centre of excellence, offering access to knowledge and serve as a reference in their chosen specific field, including activities to ensure visibility.

The proposals should

- include mechanisms to spread the latest and most advanced knowledge to all the AI-labs in Europe
- develop synergies and cross-fertilization between industry and academia
- become a common resource and shared facility, as a virtual laboratory offering access to knowledge and expertise and attracting talents
- provide broad access to AI excellence in Europe and also play an important role in increasing visibility

The proposals should include a number of major scientific and application challenges which will mobilise the community to join forces in addressing them. Continuous evaluation and demonstration of scientific and technological progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring processes) towards solving the targeted challenges will motivate the entire network and support publications and scientific career developments (providing references to publish comparative results, using the reference data, scenarios, etc.), and also showcase the technology in application contexts, to attract more user industries and eventually foster take up and adoption of the technology.

Activities are expected to achieve at least TRL 4 by the end of the project.

The proposals are expected to include mechanisms to share resources, knowledge, tools, modules, software, results, expertise, and make equipment/infrastructure available to scientists to optimise the scientific and technological progress. To that end, proposals should

exploit tools such as the AI-on-demand platform¹³⁸ and further develop and expand the platform, to support the network and sharing of resource, results, tools among the scientific community, maximising re-use of results, and supporting faster progress. Mechanisms to test results and continuously measure and demonstrate progress should be integrated in the platform, which is also important to support the scientific community, allowing also for comparative analysis. The proposals are also expected to include collaboration mechanisms among the best AI and AI-relevant research teams, but also mechanisms to bring all European AI teams to the highest level of excellence. This is also in view of supporting and encouraging the adoption of AI technologies in all Member States, with particular emphasis on geographical aspect and elimination of gaps between Member States, as well as addressing existing gender disparities.

Proposals will also exploit and develop technology enablers, such as methodologies, tools and systems and exploit latest hardware development and data spaces, cloud and HPC resources.

To ensure a balanced portfolio grants will be awarded to applications not only in order of ranking but the highest ranked in the each research focus, provided that the applications attain all thresholds.

Proposals are expected to develop synergies with relevant activities in AI, Data and robotics, primarily in destination 3, 4 and 6, but also in other destinations and clusters (in particular with cluster 3 regarding security-related activities), and share or exploit results where appropriate.

HORIZON-CL4-2021-HUMAN-01-24: Tackling gender, race and other biases in AI (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

Project results are expected to contribute to the following outcomes:

¹³⁸ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

- Increased availability and deployment of unbiased and bias-preventing AI solutions across a wide range of industrial and digital sectors
- AI-based solutions for enhancing digital equality and social inclusion for women and girls, and other groups at risk of discrimination, such as ethnic minorities and the LGBTIQ community
- Increased involvement of underrepresented persons in the design, development, training and deployment of AI.
- Increased awareness, knowledge and skills about trustworthy, bias-free and socially responsible AI in the tech industry and scientific community

Scope: Research demonstrates how bias exacerbates existing inequalities and reinforces gender, racial and other stereotypes in, for instance, the labour market, education, online advertising systems, social media, taxation and the justice system.

This topic investigates preventing and mitigating bias in AI, specifically focusing on recommender and personalisation systems, algorithmic decision-making, and surveillance software, including facial recognition. Bias in AI can occur in three dimensions: training data, bias in algorithms, and bias in the interpretation of the results.

Testing and assessment of AI systems with real-life data is needed to detect and reduce bias and improve accuracy, in line with the General Data Protection regulation. Assessing the fairness and social benefit¹³⁹ of AI-based systems and gaining more scientific understanding about their transparency and interpretation will be necessary to improve existing methods, and develop new ones in employment, advertising, access to health care, fraud detection, combatting online hate speech, and in general addressing bias affecting people's ability to participate in the economy and society. This becomes particularly relevant in light of the pandemic and ongoing social justice movements, such as #MeToo and Black Lives Matter.

In line with the European Commission's priority to strive for a 'Union of Equality', the European Pillar of Social Rights,¹⁴⁰ the Gender Equality Strategy 2020 – 2025,¹⁴¹ the EU Anti-racism Action Plan 2020-2025¹⁴², and the LGBTIQ Equality Strategy 2020-2025¹⁴³, proposals are expected to:

¹³⁹ The EC-funded Expert Group on "Gendered Innovations" recommends a rigorous social benefit review: <http://genderedinnovations.stanford.edu/case-studies/machinelearning.html#tabs-2>. See also the policy review on 'Gendered Innovations 2: How Inclusive Analysis contributes to Research and Innovation' (European Commission, DG Research and Innovation, 2020) and methodologies and case studies therein dedicated to AI, addressing gender and intersectional analysis in machine learning and robotics.

¹⁴⁰ The European Pillar of Social Rights: https://ec.europa.eu/commission/sites/beta-political/files/social-summit-european-pillar-social-rights-booklet_en.pdf

¹⁴¹ Gender Equality Strategy 2020 – 2025: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0152&from=EN>

¹⁴² EU Anti-racism Action Plan 2020 – 2025 : https://ec.europa.eu/info/sites/info/files/a_union_of_equality_eu_action_plan_against_racism_2020_-_2025_en.pdf

¹⁴³ https://ec.europa.eu/info/files/lgbtiq-equality-strategy-2020-2025_en

- Develop technologies and algorithms to evaluate and address bias in AI-based systems. These underlying methods will help addressing gender, racial, age bias, as well as bias against persons with disabilities, people from socially disadvantaged backgrounds, and the LGBTIQ community in AI-based systems, and support the deployment of such bias-free AI-based solutions.
- Develop standardized processes to assess and quantify the trustworthiness of the developed AI systems, in particular assessment of bias, diversity, non-discrimination and intersectionality¹⁴⁴ – based on different types of bias measures. This might include a methodology for considering diversity and representativeness of data, ensuring the reliability, traceability, and explainability of the AI systems, testing models on various subgroups and enabling appropriate stakeholder participation.¹⁴⁵ It could also include mechanisms to flag and remove risks of biases and discrimination.
- Develop recommender and algorithmic decision-making systems which reduce bias in recruitment and career progression and could attract more underrepresented groups, like women and girls into STEM education and into the tech industry
- Conduct trainings and awareness raising on preventing gender and intersectional bias for AI researchers, students and practitioners in line with the Digital Education Action Plan 2021 – 2027.¹⁴⁶ Trainings should also target practitioners of AI as a whole to avoid that the topic be limited to those with an already existing interest in socially responsible AI. These activities should be carried out in cooperation with the Public-Private Partnership on AI, Data and Robotics¹⁴⁷ and other relevant initiative and projects (such as the AI-on-demand platform).
- Cooperate with the Public-Private Partnership on AI, data and Robotics¹⁴⁸ and other relevant partnerships across a wide range of industrial and digital sectors, including representatives of international digital professional associations (e.g. IEEE), computing industry, hi-tech start-ups / SMEs etc. to further promote the use and uptake of the developed tools.

Proposals should focus on the development of tools and processes for design, testing and validation, including software engineering methodologies. The proposed approaches should also build tools to support deployment and uptake, auditing, certification (where appropriate).

¹⁴⁴ Intersectionality considers how different social or political identities, such as gender, race, sexual orientation, ability, ethnicity, socio-economic background, age and religion, intersect and can result in different forms of discrimination or privilege.

¹⁴⁵ See ALTAI - The Assessment List on Trustworthy Artificial Intelligence: <https://futurium.ec.europa.eu/en/european-ai-alliance/pages/altai-assessment-list-trustworthy-artificial-intelligence>

¹⁴⁶ Education Action Plan 2021 -2027, p.12: “The [Ethics] Guidelines [for Trustworthy Artificial Intelligence] will be accompanied by a training programme for researchers and students on the ethical aspects of AI and include a target of 45% of female participation in the training activities” https://ec.europa.eu/education/sites/education/files/document-library-docs/deap-communication-sept2020_en.pdf

¹⁴⁷ <https://ai-data-robotics-partnership.eu/>

¹⁴⁸ <https://ai-data-robotics-partnership.eu/>

The inclusion of underrepresented and marginalised groups in the design development, and training of the AI systems, and a transdisciplinary approach, involving multidisciplinary and intersectorial partners in the consortium will be essential.

All proposals are expected to embed mechanisms to assess and demonstrate progress towards their objectives of meeting the key requirements for removing bias (with qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring), and share results with the European R&D community, through the AI-on-demand platform, as well as the GEAR¹⁴⁹ tool to maximise re-use of results and efficiency of funding. It is essential to ensure that the publicly available results from relevant EU funded research projects (e.g. SHERPA, SIENNA, Panelfit, TechEthos) are taken into account.

Activities are expected to achieve at least TRL5-6 by the end of the project

The consortia should exchange information and build synergies with the relevant projects funded under Horizon Europe, Work programme 2021-2022 WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA¹⁵⁰.

HORIZON-CL4-2021-HUMAN-01-27: AI to fight disinformation (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Advanced AI solutions against advanced disinformation techniques.

Scope:

The Media Action Plan is developed around three areas: **recovery**, **transformation**, and **enabling and empowerment**. Research and innovation is key to the area of the

¹⁴⁹ <https://eige.europa.eu/gender-mainstreaming/toolkits/gear>

¹⁵⁰ In particular: ERA-DX-01-X-2021. ENSURING RELIABILITY AND TRUST IN QUALITY OF RESEARCH ETHICS EXPERTISE IN THE CONTEXT OF NEW/EMERGING TECHNOLOGIES. ERA-DX-01-X-2022: THE ETHICS OF ENVIRONMENTAL RESEARCH

transformation. Innovative digital solutions play an important role in ensuring a pluralistic access to trustworthy and meaningful information and quality content.

The consumption of news media has substantially increased during the COVID19 crisis, with people seeking out relevant and factual information in a time of uncertainty. Unfortunately, online services have also been used by malicious actors to spread dangerous disinformation campaigns, with sometimes fatal consequences. Similarly the need for reliable and consistent social media interactions as well as for access to audiovisual content, gaming and other interactive activities has increased during COVID-19.

Notably, media and digital literacy is one of the key pillars in fight against disinformation, as also identified e.g. in the Communication: “Tackling disinformation - the European Approach”. With the modern social media being more and more AI based, and contemporary disinformation mechanisms increasingly sophisticated, advanced means are required, to ensure a trustworthy environment. AI technologies applied to tools and services tailored to the media ecosystem will help the access to and creation and distribution of trustworthy information and facilitate countering sophisticated manifestations of disinformation.

The outcomes from this topic will offer exploitation and take-up opportunities for the Digital Europe and Creative Europe Programmes.

Research and innovation proposals are expected to:

- **Advance AI based solutions for securing a trustworthy online environment.** Disinformation techniques are already today strongly AI based. Therefore, **scientific researchers and media practitioners** need to be equipped with quantitative and semi-supervised tools based on AI, and network science driven tools of least same level of sophistication, capable of detecting different forms of deep-fakes and tampered content and to understand how and where such type of content spreads online. The development of such tools require the involvement of a scientific community at the intersection between physics, mathematics, social network sciences, social sciences and other relevant scientific fields, closely collaborating with journalists and media practitioners, and equipped with the necessary computing power to analyse rich content (e.g. videos and images) and to automate the management, processing and analysis of the flow of information within online systems.

Proposals should include, as appropriate, the development of tools and processes for design, testing and validation, deployment and uptake, auditing, certification (where appropriate), software engineering methodologies, as well as approaches to modularity and interoperability. Relevance to real-world applications should be demonstrated. Various approaches to AI for detection, elaboration of confidence levels, contradiction trade-offs, pattern identification in a field of heterogeneous sources and media formats, and also for decision support need to be considered. Involvement of multidisciplinary teams and transdisciplinary research will be essential. The consortia are strongly encouraged to team up with European companies, which are part of the media ecosystem, including SMEs, and also with non-media industrial and technological expertise.

Proposals should also coordinate and ensure complementarity with the ongoing media and social media R&I, related to projects in the field (e.g. AI4Media) and take into consideration the expectations of the Media Action Plan and the European Democracy Action Plan, and collaborate with the European Digital Media Observatory. The media data space (developed under Digital Europe) infrastructures and communities might provide an opportunity to pilot new tools produced by the selected proposal. Proposals should foresee activities to collaborate with projects stemming from relevant topics included in the Cluster 3, in particular on cybersecurity and disinformation.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring), and share communicable results with the European R&D community, through the AI-on-demand platform, a public community resource, to maximise re-use of results and efficiency of funding.

Activities are expected to achieve at least TRL5-6 by the end of the project

An Internet of Trust

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-04: Trust & data sovereignty on the Internet (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Increased trust, privacy and user control when exchanging and accessing personal data on the Internet.
- A trusted electronic identity ecosystem, fostering a universal, accessible, and user-centric digital identity as a passport to the digital society.
- A European ecosystem of top internet innovators, with the capacity to set the course of the Internet evolution according to a human-centric approach.

- New business and sustainability models based on decentralised technologies and open source.

Scope:

The EU has an advanced legal framework in the areas of data protection, cybersecurity and electronic identity. The objective of this topic is to deliver architectures, protocols and services to ensure that end-users can exert their rights (e.g. under the GDPR) and benefit from decentralised technological solutions that ensure that they are fully in control of their personal data on the Internet.

Projects proposed under this topic should develop new technologies and data governance models for increased trust, privacy and user control of personal data and identity on the internet, leveraging decentralised and self-sovereign identity approaches, empowering the end-users and enabling user-centric business and sustainability models. Solutions should enable the portability of personal data set and allow the users to transfer or share such data with organisations of their choice for purposes and under conditions they decide and control. Proposals should contribute to a trusted digital identity ecosystem that is in line with the European framework, platform-independent and user-centric and contributes to building a secure European digital identity.

The projects should support open source software and open hardware design, open access to data, standardisation activities, access to testing and operational infrastructure as well as an IPR regime ensuring lasting impact and reusability of results.

This topic has a focus on internet technologies developed for end-users (including electronic identities) and builds upon open source developments by internet innovators. It complements the activities of Destination 3 topic DATA-01-2021, which have a focus on European data spaces (technologies for data pooling, sharing and re-use), as well as those in Cluster 3 related to privacy and online identity management (e.g. FCT06-2.2021, BM02-1.2022, CS5.1.2021).

Financial support to third parties

For grants awarded under this topic for Research and Innovation actions, beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants.

Each RIA will support third party projects from outstanding open source innovators, academic research groups, high-tech startups, SMEs and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to increasing trust and data sovereignty on the Internet. Apps and services that innovate without a research component are not covered by this topic. As the primary purpose of the action is to support and mobilise internet innovators, a minimum of 80% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The consortium will provide the programme logic for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as

well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain, including in terms of standardisation. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract internet talents, to deliver value-added services to the third-party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently and efficiently (a minimum of five open calls during the lifetime of the project). They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties will be funded through projects typically in the EUR 50 000 to 200 000 range per project, with indicative duration of 9 to 12 months.

HORIZON-CL4-2021-HUMAN-01-05: Trustworthy open search and discovery (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Empowered citizens and companies to search and discover information, data, resources and people online, with increased accuracy, diversity and transparency in search results while preserving the privacy of the end-users.
- Increased European competitiveness and sovereignty in future search and discovery systems with a strong focus on serving end-users' needs (including privacy), providing trustworthy and pluralistic recommendations and increasing public trust in search results.
- A European ecosystem of top internet and social media innovators, with the capacity to set the course of the Internet evolution and the search ecosystem according to a human-centric approach.

- New sustainability models based on improved access to online data and resources and on open source.

Scope:

The objective of this topic is to develop technologies enabling new and trustworthy ways of searching and discovering information on the internet across a variety of resources such as personal, scientific, industrial and environmental data, connected devices and objects, services, multimedia content, intranets and other IT resources, public or private. It is also to empower end-users to share and discover more data and reliable information sources, while preserving their privacy and increasing public trust in search results.

Projects under this topic may notably explore advanced methods of search such as voice-based search or cognitive search combining technologies for natural language processing, semantic analysis, AI-based taxonomies, network analysis, social computing and data visualisation, enabling new ways of discovering and accessing information, in an energy-efficient way.

Proposals may also explore how to improve search infrastructures, with a view to increasing European sovereignty in future search, discovery and recommendation systems. Projects could notably design and pilot essential facilities such as web indexes and other distributed search infrastructures, with a strong focus on sustainability, security, reliability, interoperability and trust.

The projects should support open source software and open hardware design, open access to data, standardisation activities, as well as an IPR regime ensuring lasting impact and reusability of results. A scientific understanding of collective intelligence methodologies will be important to innovate beyond the current state of the art in search and recommendation systems and contribute to a better governance of social networks.

This topic contributes to the Media Action Plan (MAP), which aims to support the digital transformation of, and collaboration within, the social media industry.

Financial support to third parties

For grants awarded under this topic for Research and Innovation actions beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants.

Each RIA will support third party projects from outstanding open source innovators, academic research groups, high-tech startups, SMEs, social innovators, and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to building a more open, trustworthy and user-centric search and discovery ecosystem. Apps and services that innovate without a research component are not covered by this topic. As the primary purpose of the action is to support and mobilise internet and social media innovators, a minimum of 80% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The consortium will provide the programme logic for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain, including in terms of standardisation. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract internet talents, to deliver value-added services to the third-party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently and efficiently (a minimum of five open calls during the lifetime of the project). They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties will be funded through projects typically in the EUR 50 000 to 200 000 range per project, with indicative duration of 9 to 12 months.

HORIZON-CL4-2021-HUMAN-01-07: Next Generation Internet community-building and outreach (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- A vibrant community of Internet innovators and stakeholders, with the capacity to set the course of the Internet evolution according to a human-centric approach.

Scope: The aim of the topic is to co-design and execute the Next Generation Internet community-building and communication and outreach strategy.

The project will support the European Commission in engaging a diverse community of stakeholders, including internet innovators, researchers, start-ups and SMEs, but also policy

makers, internet end-users, social partners, local communities and citizens at large, in order to develop and implement the NGI vision of a human-centric internet. It will liaise with similar initiatives at national and regional level. It will help grow the community by promoting broad stakeholder engagement in NGI activities and projects, in particular by engaging internet innovators who are new to EU programmes. The project will seek to ensure through dedicated activities diverse participation in terms of profiles, gender, age, ethnic group, abilities, and nationality (including from neighbouring regions). It will have dedicated activities to promote the involvement of women innovators.

The project will support the European Commission in NGI branding and marketing activities, including extensive online and social media presence, press coverage and participation in key events, establishing a positive brand image in the Internet community and the public at large. Based on advanced digital and non-digital communication techniques, the project will lead NGI communication activities and coach other NGI projects in effective communication and marketing.

HORIZON-CL4-2021-HUMAN-01-08: NGI International Collaboration - Transatlantic fellowship programme (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Enhanced EU-US and EU-Canada cooperation in the development of Next Generation Internet technologies, services and standards.
- Supporting the EU internet policy objectives by sharing the EU vision and values with US and Canadian counterparts and forging bonds through concrete collaborations.
- A transatlantic ecosystem of top researchers, high-tech startups / SMEs and Internet-related communities collaborating on the evolution of the Internet according to a human-centric approach.

Scope: The aim of the topic is to reinforce EU-US and EU-Canada cooperation in the area of Next Generation Internet, and to establish a continuous dialogue among US, Canada and EU

innovators. The focus will be on trust and data sovereignty and on internet architecture renovation and decentralised technologies.

A CSA will organise a fellowship programme providing support to European Internet innovators to travel to the US or to Canada to work and collaborate with US and Canadian counterparts, with a view to promoting knowledge-sharing and establishing long-term collaborations on NGI technologies, services and standards.

The project is expected to provide financial support to third parties, from open source developers, to academic researchers, hi-tech startups, SMEs and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to enhancing EU-US and EU-Canada cooperation in the development of Next Generation Internet technologies and services.

HORIZON-CL4-2021-HUMAN-01-09: NGI Tech Review (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Increased value and maturity of internet technologies tackling key societal challenges such as response to pandemics, climate change, disinformation, or the protection of privacy.
- Improved collaboration of scattered communities of internet innovators.

Scope: The COVID-19 crisis demonstrates that complex challenges of today cannot be solved by one organisation/country, nor without the support of digital technologies. Open collaboration of innovators from multiple background loyal to EU values is a critical factor for the development of successful European solutions.

The scope of this topic is to support an open environment fostering collaboration between internet innovators to tackle key societal challenges such as response to pandemics, climate change, disinformation, or the protection of privacy. The environment will bring together

internet innovators, including NGI innovators, to develop, test and improve solutions based on open source technologies.

The funding covers the setting up and operation of the open collaboration environment, including the needed IT infrastructures; community management activities; and support to innovators in a broad range of areas including security, accessibility, privacy. The funding does not cover the funding of innovators to develop new solutions.

eXtended Reality (XR)

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-13: eXtended Reality Modelling (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- Large-scale creation of eXtended Reality models with increased levels of interaction, context awareness, explainable autonomous decisions, human control, privacy and accessibility.
- Methodologies and tools to build eXtended Reality services based on these models.
- Improved human to human and human to computer eXtended Reality interaction, in both offline and real-time context.

Scope: Recent advances in the field of Artificial Intelligence (AI) giving machines the ability to understand and derive meaning from human languages, have shown that automatic systems can exhibit human-like performance. Machine translation, speech recognition or personal assistants are now part of our daily lives. Recent progress in AI has also enabled systems to generalise from one task to another, from one language to another, from one modality to another. Large pre-trained multilingual language models can handle different languages, even with little or no training data. The same models can cover completely different language-related tasks, such as text translation or summarisation, speech transcription, or sentiment

analysis. Advances in user and environment modelling and progress in data analytics allow systems to be increasingly context-aware and efficiently support users in their decisions.

Drawing on the above-mentioned recent advances, the proposed projects will:

- Develop pre-trained eXtended Reality (XR) models capable of adapting to a large variety of forms of expression, interaction, languages, domains, styles and intent. Taking into account surrounding real or virtual environments, contexts, preferences and abilities of the user, the models will contribute to the general understanding of the environments and users' knowledge, preferences, beliefs, abilities, intent and goals.
- Demonstrate the adaptation and generalisation of the eXtended Reality models, including through the integration of structured knowledge, by developing solutions capable of carrying genuine human-like interaction before, during and after an eXtended Reality experience.
- Integrate the solutions into several eXtended Reality use-cases scenarios, such as media, collaborative telepresence, learning, personal assistants or information retrieval.

Beyond supporting a large set of languages and modalities, the work will focus on enabling new forms of interactions, avoiding bias, whilst ensuring accessibility, privacy, transparency and explainability.

To compensate the increase of model complexity, the proposed solutions should be energy efficient thanks to optimised protocols and algorithms with equivalent performance during both training and implementation.

The project will ensure reproducibility and repeatability of the research results, promote an open data and interfaces standardisation, avoiding narrow de-facto standards and demonstrate clear and efficient integration paths for the European industry take up.

To further extend the application domains, address sector specific constraints, ensure reproducibility and demonstrate their integration paths, projects are expected to organise a number of competitive calls with financial support to third parties (FSTP) and further extend the use-cases. At least 20% of the funding should be dedicated to FSTP. To that aspect, the consortium will provide guidelines and technical support in engineering integration, testing and validation to support the development of such use-cases.

HORIZON-CL4-2021-HUMAN-01-14: eXtended Reality for All – Haptics (RIA)

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

<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

Projects are expected to contribute to the following outcomes:

- Specific eXtended Reality haptics hardware able to provide affordable portable devices for instantly refreshable full-page interactive tactile displays which enable navigating, reading and editing digital content in both standard braille and tactile graphics format for the blind and visually impaired¹⁵¹;
- Establish Europe as a world leader in developing accessibility solutions.

Scope:

eXtended Reality (XR), combining human-machine interactions and all real, mix, augmented and virtual environments, allow users to interact with real-time contextual information activated by intuitive sensory triggers. However, in order to provide eXtended Reality for all (XR4All), specific accessibility oriented development is required.

Indeed, certain categories of information such as scientific formulae, computer code, tabular data, photos and images cannot be efficiently rendered by the blind and visually impaired by using braille readers or text to speech technologies. Furthermore, the increase of distant learning and teleworking has highlighted the lack of tactile feedback possibilities and increased the gap for visually impaired accessibility.

Existing tactile solutions are limited to refreshable braille displays which are bulky and/or prohibitively expensive. They offer a limited reading experience by providing only a single line of characters at a time and their output is considerably slower than an experienced user's ability to read braille.

Drawing on the above-mentioned conclusion, the proposed project will develop an affordable, portable, usable full-page devices able to convey and input digital information in both braille and tactile graphics for people with visual impairments.

Consortium will pay attention to develop solutions that are reliable, robust, safe and meet the needs and preferences of visually impaired people. The solution need to be interoperable with other ICT devices, including other assistive technologies, provides open APIs for use by third parties and allow for back-translation of braille or tactile graphics into text or images to enable cooperation between visually impaired and sighted people.

¹⁵¹ The [European Blind Union](#) estimates that there are over 30 million blind and partially sighted persons in geographical Europe.

People with visual impairments should be involved in all stages of the research and development. Their involvement in validating the solution is a minimum requirement.

HORIZON-CL4-2021-HUMAN-01-25: eXtended Collaborative Telepresence (IA - FSTP)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

Expected Outcome:

Projects are expected to contribute to the following outcome:

- Establishing European industry leadership in eXtended collaborative telepresence solutions, while ensuring ethics, privacy and safety.

Scope: This topic aims to increase the European competitiveness and innovation capacity and foster the adoption of European eXtended collaborative telepresence technologies in both professional and private spheres, taking benefit of combining real and virtual environments to improve distant human-human interactions through wearables and computer mediated technologies.

The COVID-19 pandemic has caused major disruptions to the way we work and live. Physical distancing and global lockdown, as well as pressing climate and environmental concerns, have accelerated the need for development and adoption of telepresence technologies to sustain the productivity of remote and online contactless activities, as well as maintaining social bonds. With a worldwide CO2 emission reduction of more than 20%, the crisis has also revealed that teleworking and reduction of travel is an efficient mitigating solution. Tools supporting enhanced teleworking have become of primal importance.

However, existing collaborative telepresence tools and solutions raise concerns in terms of functionalities, interoperability, efficiency, versatility, openness, accessibility, security and privacy of personal data.

Proposals should leverage existing open standards and technologies in the domain of eXtended Reality (XR), combining human-machine interactions and all real, mix, augmented and virtual environments, accessibility, networks, security and privacy to provide low-cost and widely available eXtended collaborative telepresence solutions.

To ensure wide take-up, proposals should demonstrate their capacity to scale up by involving high numbers of end-users in tests in real environments.

The proposals are expected to address several of the following points:

- Support a wide range of networking bandwidth with adequate compression transmission of information so as to optimise end-to-end quality of service;
- Support different input and output modalities as the bandwidth capacities extend (text, speech, audio, video, AR/VR, 3D, holography);
- Through open standards, support the integration of additional services such as recording, speech transcription, translation, anonymization, summarisation, context-aware instant search;
- Optimise the results of eXtended collaborative meetings through easy access, analysis and syntheses of recordings;
- Protect user privacy, through a mix of necessary technologies (encryption, blockchains, edge-processing, standardisation, ...);
- Develop, document and promote open standards based interfaces (such as APIs) which can be used by third parties to further enhance the project solutions and adapt them to other environments and user needs.
- Provide systems to facilitate human-to-human and human-to-machine interaction, that allows real-time as well as offline communication;
- Apply eXtended Reality technologies to support the communication and collaboration experience;
- Apply eXtended Reality models to enhance the collaborative aspects of telepresence;
- Apply haptics devices to further improve the intuitiveness and accessibility of the solutions;
- Follow existing and propose new standards ensuring the privacy and security of the users to guarantee compliance with the European legal framework on personal data protection taking into account the complexity and particularities of eXtended Reality technologies;
- Demonstrate clear and efficient integration paths for take-up by European industries;

To further extend the application domains, guarantee reproducibility and demonstrate the integration paths, projects are expected to organise a number of competitive calls with financial support to third parties (FSTP). At least 50% of the funding should be dedicated to FSTP. To that end, the consortium will provide guidelines and technical support with expertise in engineering integration, testing and validation to support the development of such

use-cases. The maximum amount of FSTP, distributed through a grant, is EUR 200.000 per third party for the entire duration of the action, but smaller amounts may also be justified.

HORIZON-CL4-2021-HUMAN-01-06: Innovation for Media, including eXtended Reality (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

Expected Outcome: Prototyping of advanced solutions for the creation, distribution and consumption of new immersive and innovative products for media. Support innovation in media, including XR innovation, through interdisciplinary cooperation, involving various professional groups (including artists, designers, journalists and media professionals, filmmakers, game designers, programmers or academic researchers). The two priorities are:

- Foster the development of advanced solutions for the creation, distribution and consumption of new media products, including extended reality, in view of the Media Data Space to be deployed through DEP.
- Foster the creation of a European VR MediaLab.

Scope:

The Media Action Plan, aimed at supporting media industry recovery, has three areas: Recovery, transformation, and enabling and empowerment. **Transformation** foresees innovation actions to support transformation of media industry, and the creation of a European Virtual and Augmented Reality (VR/AR) Industrial Coalition^[1].

Two key ingredients of such transformation are, among others, on the one hand, data know-how and innovation in modular open-source media components, and on the other hand, the development of immersive technologies. Both entertainment and news media have great opportunities for groundbreaking innovations and inventive business models building on the potential of new technologies, including XR.

Two types of innovation proposals are expected:

- i. The **development of new modular tools, components and/or services** addressing technical, organisational, commercial and legal aspects of data management and usage for

new media applications. The innovative solutions should be proven useful for the creation and distribution of new formats, in particular of formats that use XR technologies and that could be expandable or applicable, in addition to news media, to the media industry at large and have a potential to be consumed in new environments (e.g. self-driving cars, intermodal transport and tourism). To this end, cooperation within the media sector and across different industrial sectors will be beneficial for the creation of synergies based on the use of data applications.

Collaboration with the media data space will be encouraged already at its initiation phase, and full interoperability with and deployability on it are highly recommended. Once it will be operational, the Media Data Space deployed under the Digital Europe programme will offer the opportunity to the projects supported by this Call to test and pilot their innovative solutions.

ii. The launch of a **dedicated VR Media Lab to foster innovation and new solutions in the field of VR/AR Media**. The Lab will develop and prototype advanced solutions for the creation, distribution and consumption of new immersive VR/AR media products and foster innovation by exploring a range of uses for VR/AR technologies, and bring together skills from a variety of disciplines, including technology and the creative sector, to develop new solutions for consumers, business and society.

The VR Media Lab will support creative cooperation on projects that focus on new ways of storytelling and interacting through immersive media. The funded third party projects will focus on content for entertainment, culture and news, as well as virtual and augmented reality applications in other industries, such as tourism, and fields such as education. Solutions developed as part of the VR Media Lab could result in new business models, technological solutions, spinoff companies or partnerships.

At least 1 proposal will be funded for the innovation type i.

One proposal will be funded for type ii.

Financial support to third parties

For grants awarded under the type ii Innovation actions, beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants. Each IA for type ii will support third party projects from outstanding media innovators, SMEs and other multidisciplinary actors, so that multiple third parties will be funded in collectively contributing to the innovation area. The consortium will provide the programme logic and vision for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract relevant top talents, to deliver a solid value-adding services to the third-party projects, as well

as their expertise and capacity in managing the full life-cycle of the open calls transparently. As support and mobilising of media innovators is key to the type ii IA of this topic, a minimum of 70% of the total requested EU contribution should be allocated to financial support to the third parties.

The Commission considers that proposals with an overall duration of typically xx months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties in type ii will be funded through projects typically in the EUR 250 000 to 500 000 range per project, with indicative duration of 12 to 15 months.

[i] <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0784>

HORIZON-CL4-2021-HUMAN-01-15: eXtended Reality Learning - Engage and Interact (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- To develop innovative eXtended Reality applications for learning, training and education
- To test and support take-up of proven, successful eXtended Reality tools, making Europe a leader in cutting-edge technologies for education

Scope: eXtended Reality (XR), combining human-machine interactions with real, mix, augmented and virtual environments, allows for higher engagement with teaching material and more efficient interaction with complex problems or new environments. Projects will make use of XR technologies to develop and test virtual tools for teaching and learning.

The selected project will create a European reference platform on learning and teaching with XR with the aim to:

- Develop, apply and test the use of eXtended Reality technologies, in education , such as for virtual field trips, content creation and exploration (STEM, history, etc.), awareness of climate changes and biodiversity challenges, training of young professionals and

upskilling (healthcare and medical, manufacturing, construction and engineering), distance and blended learning, accessibility and inclusion;

- Provide access to teachers, students, parents and school administration to a reference platform where they can find educational solutions appropriate for their educational needs;
- Build a focal point where the EdTech and XR community (including SMEs, start-ups, companies, academia/research community, learning and instructional designers, social innovators) can share/market their existing digital educational XR solutions, including those developed in the context of EU funded projects;
- Further support digital start-ups, SMEs and industry active in the sector through “Financial Support for Third Parties” actions allowing them to further advance early prototypes of XR educational solution to a market-ready product, with the overall aim to populate the on-demand education platform;
- Build upon and link to existing relevant initiatives, including for instance existing platforms, catalogues or repositories;
- Reach out to potential user groups through awareness-raising and communication activities to boost the use of the platforms.

The project will be populated with FSTPs and smaller projects such as:

- FSTP projects for fully developed, tested and ready-to-deploy digital learning solutions/apps using XR;
- FSTP XR for education projects including Mini-Piloting projects/schools to be used for user-tests/examples/communication

The actions shall select these small scale projects through the use of financial support to third parties. A minimum of 60% of the EU funding of the action should be allocated to the financial support of these third parties, typically of the size of EUR 150 000 to 300 000 per third party and a duration of about 9 to 12 months. Financial support to third parties should in line with the conditions set out in the General Annexes.

In order to facilitate the integration with existing IT systems and policies, the EU XR platform for education should only accept XR content, tools and solutions based on open standards, such as OpenXR and WebXR and should offer publicly available access to XR content, tools and solutions, without passing through app stores.

HORIZON-CL4-2022-HUMAN-01-16: eXtended Reality Ethics, Interoperability and Impact (CSA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- A strong and competitive ecosystem, with European companies playing a leading role in the wider deployment, adoption and acceptance of eXtended Reality technologies.
- Improved quality of eXtended Reality experiences and applications, combining human-machine interactions and real, mixed, augmented and virtual environments and ensuring ethics, privacy and safety.

Scope:

New ethical risks and privacy concerns arise as experiences based on eXtended Reality (XR) become more realistic and immersive, blurring the line that separates them from the real world.

Although the applications investigated and developed to date aim to provide benefits to individual and society, eXtended Reality technologies may also have harmful physical, emotional and cognitive after-effects.

The potential amount and type of information collected, processed and stored by applications based on eXtended Reality technologies may put individuals at high privacy and security risk.

Interoperability and safety are another major concern for the uptake of eXtended Reality technologies. The lack of widely accepted standards slows down the development process and increases design and testing costs. Several initiatives are trying to devise the industry standards at a global level; however, European players are underrepresented in such initiatives.

The selected project will help structuring and supporting the eXtended Reality community in Europe by

- devising responsible practices and guidance helping developers and producers of eXtended Reality experiences and applications to respect ethics and privacy values while ensuring the safety of the users;
- defining an European cross-industry code of conduct for eXtended Reality technologies and solutions while encouraging developers and producers to adhere to it;

- proposing new, or adapting existing, rating systems to support users in choosing the right eXtended Reality experiences and applications;
- gathering relevant evidence to help guarantee the respect of the European legal framework on personal data protection, taking into account the complexity and particularities of eXtended Reality technologies;
- fostering the contribution of European players to the definition of industry standards on eXtended Reality technologies ensuring interoperability and seamless integration with other relevant systems, technologies and data sources;
- helping to forge a competitive and sustainable ecosystem for the European eXtended Reality technologies industry by strengthening the links and promoting collaboration among the constituency, including EU-funded projects.

Systemic approaches to make the most of the technologies within society and industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-17: Awareness raising on Intellectual property (IP) management for European R&I (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Increased awareness among knowledge generators of the importance of the generation, protection, management and use of IP for the development of key technologies and achieving sovereignty in strategic value chains.
- Stronger open innovation ecosystems by providing guidance and best practice examples on how to use the intellectual property.
- Increased and optimised use of intellectual assets to promote innovation with high value to the economy and society.

Scope: The EU's new Industrial Strategy aims for Europe to lead the next wave of technology based innovations, transforming scientific breakthroughs into world leading companies. To achieve technological sovereignty in critical technology areas, the management of intellectual property, from the early stages of the knowledge creation process to the final deployment of solutions, is key.

IP management is considered one of the main challenges facing valorisation of knowledge and research. Better awareness of appropriate IP management enables transforming R&I results into ground-breaking technological solutions, and enhances open innovation ecosystems.

The action will address the need to increase awareness and knowledge on intellectual property management. It will build the bridge between technology generation and technology upscaling via IP management awareness. It will address the knowledge generators, early career researchers, researchers, entrepreneurs in the making etc., regardless of their gender, age or background.

The action will include an awareness campaign as well as specific activities to support academia, research institutions and SMEs on the management and valorisation of IP to demonstrate public value. The action will not overlap or duplicate existing initiatives but should build on them and maximize the impacts as well as seek synergies with major European level intellectual property actors.

HORIZON-CL4-2021-HUMAN-01-18: Fostering standardisation to boost European industry's competitiveness (CSA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Coordination and Support Actions
<i>Funding rate</i>	100%

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

- Reinforcing the links between research, innovation and standardisation ensuring that standardisation is an integral part of the European research and innovation landscape.
- Facilitating the entry to market of innovative solutions, which could address major societal challenges such as climate change and digitalisation.

- Promoting standardisation as an important enabler towards the enhancement of the competitive edge of the European industry.

Scope: As emphasised in the European Green Deal and in the New Industrial Strategy for Europe, developing new standards, coupled with increased EU participation in international standardisation bodies, will be essential to boost industry's competitiveness and build a sustainable and more inclusive future.

This action will identify obstacles hampering standardisation efforts of research generators, develop remedies to the obstacles, and propose solutions to foster standardisation as a means of knowledge valorisation by engaging with relevant standardisation bodies.

The action will create an interface to facilitate networking between the beneficiaries and their national, European, international standardisation bodies for the exploitation and valorisation of EU funded research results, organise trend analysis workshops, and promote the discussion between R&I and standardisation. This interface will be a one-stop-shop for all these related matters.

HORIZON-CL4-2021-HUMAN-01-19: Testing innovative solutions on local communities'-demand (IA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Innovation Actions
<i>Funding rate</i>	70%

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

- Increased societal uptake of new technologies and knowledge-based solutions, achieved through better understanding of societal needs and higher societal acceptance;
- Increased place-based innovation and experimentation, through testing of up to 100 innovative new solutions in partnership with cities and local communities, research and industry, drawing on local characteristics and strengths;
- Increased innovation capacity across Europe, through new models of co-creation and exchange of good practises and learning from experimentation, so that innovative solutions are shared and adapted to the needs of local communities (avoiding 'one size fits all').

Scope: This action will promote the uptake of research-based technological and non-technological solutions in cities and local communities by responding to concrete, citizen driven, demand for testing and experimentation. By addressing the local societal demand for innovative solutions and bringing forward R&I to match communities' needs, the action will contribute to implementing the European Green Deal's aim "to involve local communities in working towards a more sustainable future, in initiatives that seek to combine societal pull and technology push". By matching needs to (candidate) new solutions stemming from EU R&I, and testing these solutions in a transparent and socially inclusive way, the action will contribute to technology uptake with citizen engagement, in line with the aims of the European industrial strategy.

Within the scope of this action is to co-create and test societal solutions, so that R&I developed in Europe can be tested in Europe, jointly with local communities. The scaling up of the effective solutions is not within the scope of this action, and will be facilitated through other programmes and initiatives (public and/or private). The core concept lies in collecting, and then matching, needs of cities and communities with supply of possible solutions from research results, involving adaptation to local needs, testing in real environments (cities/communities as testbeds) and ensuring benefits for all parts of society.

Main beneficiaries of this action will be the participating cities and local communities, together with the research and business partners involved in the testing and further uptake of the innovative solutions. The action may engage planners, designers, architects, artists, climate scientists, policy makers, investors, social innovators, local professionals and small businesses. It will draw on the diversity of the local environments and their needs and concepts for societal transformations and facilitate the sharing of experiences and lessons learned. The consortium may provide financial support to third parties. The maximum amount to be granted to each third party is EUR 60 000. The respective options of the Model Grant Agreement will be applied.

Social innovation is recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

HORIZON-CL4-2021-HUMAN-01-20: Piloting a new industry-academy knowledge exchange focussing on companies' needs (CSA)

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

<i>Funding rate</i>	100%
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Expected Outcome: Projects are expected to contribute to the following outcomes:

- Stronger industrial ecosystems in Europe through reinforced industry-academy collaboration.
- Enhanced use of the European pool of talents and skills supporting the European industry to deliver innovative solutions.
- Upskilling university students for their entrepreneurial and transversal skills by offering early exposure to real business environment and problem solving.
- Increased competitiveness of the European industry by facilitating access to knowledge and talents.

Scope: This action will promote industry-academy knowledge exchange focussing on companies' research and innovation needs, complementing university-business collaboration in line with the European Skills Agenda for sustainable competitiveness, social fairness and resilience¹⁵².

This activity will build on already existing instruments in the field of university-business cooperation such as EIT Knowledge Innovation Communities and Knowledge Alliance. Gap analysis of the existing EU instruments in the field of university-business cooperation shows that there is a need for enhancing the support for ad-hoc collaborations focussing on companies' specific needs. This activity will develop and pilot, in coordination with the European Institute of Innovation and Technology (EIT), a standard collaboration module that will support short-term gender-balanced co-creation teams of HEI¹⁵³ students, researchers and companies own R&D personnel to work jointly to solve the company's identified R&I and business challenges. The students and researchers in each co-creation team must come from at least three EU Member States or Associated Countries. Participation of companies across the EU and Associated Countries should be ensured with particular emphasis on widening countries.

The co-creation process will be facilitated by a platform through which companies can find the most suitable, skilled and motivated international teams on ad-hoc basis to work together with the company staff to find a solution. The platform will be in charge of matching the company with individuals to form a bespoke and fit-for-purpose interdisciplinary diverse team to tackle the particular challenge in question. Furthermore, the platform will be in charge of the project management for the co-creation teams and provide the teams with professional guidance and facilitation to solve the defined challenges within a limited period of time. Beneficiaries may provide financial support to third parties to support co-creation teams. The maximum amount to be granted to each third party is EUR 60 000. The respective options of the Model Grant Agreement will be applied.

¹⁵² COM/2020/274 final

¹⁵³ Higher Education Institution

HORIZON-CL4-2021-HUMAN-01-21: Art-driven use experiments and design (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

Dedicated collaboration of industry with artists in R&D projects will lead to novel products and services in line with a European human-centred approach to innovation. This will

- Stimulate uptake of digital technologies across selected sectors - (Green) Manufacturing, Mobility/Urbanism, Health, Agriculture, and Space through art-driven experimentations implementing these technologies including associated processes and solutions.
- Increase trust in and acceptance of digital technologies in society through art-driven design and development of digital technologies that allow new forms of experience and demonstrate empathy by ensuring that the development process and system behaviour of the technologies explicitly acknowledge human values and needs, also for a healthy generation and inclusive society.

Scope: Design of technology and deployment in selected sectors in use cases will be explored between stakeholders in industry – engineers, developers and end-users – and artists through dedicated industrial projects in continuation of the S+T+ARTS lighthouse pilots¹⁵⁴. The role of the art will be to (i) conceive challenging human-centred use scenarios, (ii) explore alternative design methods for technologies using artistic practice. Artists are contributing in system design and system testing and by allowing exploration of technology in an artistic context. The call addresses all digital technologies but in particular AI.

Social innovation is recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

HORIZON-CL4-2021-HUMAN-01-23: Support for National Contact Points in Digital, Industry and Space

Specific conditions

¹⁵⁴

www.STARTS.eu

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- An improved and professionalised NCP service across Europe, in the areas of Digital, Industry and Space, thereby helping simplify access to Horizon Europe calls, lowering the entry barriers for newcomers, and raising the average quality of proposals submitted;
- A more consistent level of NCP support services across Europe.
- Widening participation to projects in these areas to new players.
- Proposals should include a work package to implement matchmaking activities to link up potential participants from widening countries with emerging consortia in the domain of Cluster Digital, Industry and Space . Matchmaking should take place by means of online tools, brokerage events, info days and bilateral meetings between project initiators and candidate participants from widening countries. Other matchmaking instruments may be used as appropriate.

Scope: Proposals should aim to facilitate trans-national co-operation between National Contact Points (NCPs) in the areas of Digital, Industry and Space covered by this part of the Work Programme, with a view to identifying and sharing good practices and raising the general standard of support to programme applicants.

While proposers may wish to foresee specialised services covering the different areas of this cluster, proposals must ensure the cohesion of different services, capitalising on economies of scale; and ensuring that good practices are diffused across sectors and opportunities for collaboration across the cluster are enhanced.

Given the importance of human-centric approaches in this cluster, the project should attract new types of player to the cluster, for instance social innovation players, makers and youth associations. Appropriate expertise from social sciences and humanities (SSH) should be included.

Special attention should be given to enhancing the competence of NCPs, including helping less experienced NCPs rapidly acquire the know-how built up in other countries.

The proposal should cover the whole duration of Horizon Europe.

HORIZON-CL4-2021-HUMAN-01-26: Workforce skills for industry 5.0 (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- A quantitative and qualitative assessment of the nature of job transformations in the context of the 4th industrial revolution, estimating and mapping the emerging occupations. Establishment of an “Industry 5.0 platform” for future skill requirements improving the critical understanding of the ‘black box’ of new jobs creation;
- guidance and recommendations, including avenues for new learning and training systems, for policy-makers, businesses, individuals, to reduce the skills’ gaps, to cope with possible unemployment effects, to foster industrial competitiveness while enhancing inclusiveness.

Scope: The 4th industrial revolution, has been associated with production efficiencies, cost reductions, streamlined labour requirements and business model adaptations. However, this is accompanied with social, economic and organizational challenges such income inequalities, public perception for job quality and scarcity, legal issues and data security. The RIA will investigate the social and economic impacts generated by emerging disruptive technologies (artificial intelligence & machine learning, block chain, big data, internet of things, 5g, etc.), robotisation and digitalization on labour markets and business models. They will explore innovative methodologies in redefining work activities and automatable tasks also through an historical comparison with previous industrial revolutions, including cultural, ethical, and regional perspectives, combining the tools of social sciences and humanities (SSH) disciplines with the insights of industry leaders (large companies, SMEs, regional ecosystems) and social partners. Several dimensions shall be explored: job nature and skills including the impact generated by the covid-19 outbreak, labour productivity, employment and mobility, quality and new forms of work, business value chains, management and organisational models, gender aspects, workplace and socio-demographic characteristics, territorial structures. Proposals will comprehensively assess how benefits are distributed in all sectors and, keeping into account similar ongoing exercises (e.g. OECD, CEdefop, etc..) as well as national industry 5.0 initiatives, they will forecast the expected dominant trend of jobs, mapping the emerging occupations and predicting the future skill needs and shifts by industry,

also improving the critical understanding of those which cannot be automated (creativity, social intelligence, problem-solving, etc..).

Furthermore distinctive learning trajectories and training paths will be identified for both STEM and soft skills, including combined public-private learning ecosystems and collaborative learning techniques/tools. Skills taxonomies will be developed in order to monitor track changes in the demand that are continually challenged by technological progress, thus contributing to close unintended skill gaps and unemployment spill-overs.

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.

Social innovation is recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

Call - A HUMAN-CENTRED AND ETHICAL DEVELOPMENT OF DIGITAL AND INDUSTRIAL TECHNOLOGIES 2022

HORIZON-CL4-2022-HUMAN-01

Conditions for the Call

Indicative budget(s)¹⁵⁵

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million) ¹⁵⁶	Number of projects expected to be funded
HORIZON-CL4-2021-HUMAN-01-11	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-01	RIA	Around N/A	Not relevant	

¹⁵⁵ 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 2021 and 2022.

¹⁵⁶ Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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HORIZON-CL4-2022-HUMAN-01-02	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-03	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-05	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-07	RIA	Around N/A	Not relevant	
HORIZON-CL4-2022-HUMAN-01-08	RIA	Around N/A	Not relevant	
Overall indicative budget				

General conditions relating to this call

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

Leadership in AI based on trust

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-HUMAN-01-01: AI for human empowerment (RIA)

Specific conditions

<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Truly mixed human-AI initiatives for human empowerment
- Trustworthy hybrid decision-support systems

Scope:

Build the next level of **perception, interaction and collaboration** between humans and AI systems working together as partners to achieve common goals, sharing mutual understanding and learning of each other's abilities and respective roles.

Each proposal will focus on one of the two following research objectives:

- Reach truly mixed human-AI initiatives for human empowerment. The approaches should combine the best of human and machine knowledge and capabilities including shared and sliding autonomy in interaction, addressing reactivity, and fluidity of interaction and making systems transparent, fair and intuitive to use, which will play a key role in acceptance. The systems should adapt to the user rather than the opposite, based on analysis, understanding and anticipation about human behaviour and expectations.
- Trustworthy hybrid decision-support, including approaches for mixed and sliding decision-making, for context interpretation, for dealing with uncertainty, transparent anticipation, reliability, human-centric planning and decision-making, interdependencies, and augmented decision-making. Transparency, fairness, technical accuracy and robustness will be the key, together with validation strategies assessing also the quality of the decision of the AI supported socio-technical system.

All proposals should adopt a human-centred development of trustworthy AI and investigate and optimise ways of human-AI interaction, key for acceptance and democratisation of AI, to allow any user to take full advantage of the huge benefits such technology can offer, regardless of their age, race, gender or capabilities. This includes development of methods to improve transparency, in particular for human users, in terms of explainability, expected levels of performance which are guaranteed/verifiable and corresponding confidence levels,

accountability and responsibility, as well as perceived trust and fairness. AI could also be used to empower humans in supporting them to improve responsible behaviours, where appropriate, but this should be done in full respect of the requirements ensuring trustworthy AI, including human autonomy.

Innovative scientific approach towards human-centric approaches will require multidisciplinary and trans-disciplinary approaches paying particular attention to intersectional factors (gender, ethnicity, age, socioeconomic status, disability) including SSH and other disciplines relevant to stimulate novel research avenues, and eventually improve user-acceptance. Collaborative design with users involvement should also be considered.

As a pilot activity, proposals in this topic will dedicate part of their activities on investigating novel ways of engagement by citizens or citizen representatives with AI development, with a view of optimising experience towards improving usability and experience for citizens (both at professional or daily life environment).

All proposals should contribute to build the next level of perception, interaction and collaboration, and understanding between humans and AI systems working together as partners to achieve common goals, sharing mutual understanding of each other's abilities and respective roles.

All proposals are expected to embed mechanisms to assess and demonstrate progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring, as well as illustrative application use-cases demonstrating concrete potential added value), and share results with the European R&D community, through the AI-on-demand platform¹⁵⁷, a public community resource, to maximise re-use of results, either by developers, or for uptake, and optimise efficiency of funding. Activities are expected to achieve TRL 4-6 by the end of the project

To ensure a balanced portfolio covering a broad range of AI research areas, grants will be awarded to applications not only in order of ranking but at least 2 highest ranked each of the research foci, provided that the applications attain all thresholds.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

HORIZON-CL4-2022-HUMAN-01-02: European Network of AI Excellence Centres: Expanding the European AI lighthouse (RIA)

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

¹⁵⁷ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Expanding the European AI lighthouse¹⁵⁸
- Reinforcing the leading unified European AI, data and robotics community
- Advances in the major AI, data and robotics challenges hampering its deployment

Scope:

This initiative will pursue the initiative started in H2020 to develop a vibrant European network of AI excellence centres, and a vibrant AI scientific community, and continued in the first call of Horizon Europe, through the Human-04-2021, establishing the European AI lighthouse in building its first pillars.

To ensure European strategic autonomy in such critical technology as AI, data and robotics, with huge potential socio-economic impact, it is essential to reinforce and build on Europe's assets in such technologies, including its world-class researcher community, in order to stay at the forefront of technological developments.

As stated in the communication from the European Commission on Artificial Intelligence for Europe and the coordinated action plan between the European Commission and the Member States, while Europe has undeniable strengths with its many leading research centres, efforts are scattered. Therefore joining forces will be crucial to be competitive at international level. Europe has to scale up existing research capacities and reach a critical mass through tighter networks of European AI excellence centres. The proposals should develop mechanisms to reinforce and network excellence centres in AI, bringing the best scientists from academia and industry to join forces in addressing the major AI challenges hampering its deployment, and to reinforce excellence in AI throughout Europe via a tight network of collaboration.

Such networks are expected to mobilise researchers to collaborate on key AI topics and to increase the impact of the funding in progressing faster in joined efforts rather than working in isolation, with fragmented and duplicated efforts. Such networks, together with other mechanisms, will play an important role in reaching critical mass and in overcoming the present fragmentation of AI research in Europe.

Proposals will mobilise the best European teams in AI, data and robotics community to join forces to address major technical as well as sector- or societal-driven challenges: strengthening excellence, networking, multidisciplinary, academia-industry synergies.

¹⁵⁸ In this section AI is taken in the broad sense and covers AI, data and robotics

Proposals will develop Networks of excellence centres including mechanisms to joining forces addressing the following objective:

- Expanding the **European AI lighthouse**, a virtual center of excellence for research, innovation and expertise, to become a world reference in AI and that can attract investments and the best talents in the field. The virtual center will build on key pillars, each of them being a network of excellence centers specialising in a given sector where Europe has the potential to become a global champion, in particular exploiting the potential benefits AI can bring to such sector, and capable of mobilising the corresponding industrial ecosystem. The batch of projects in this call will expand the European AI lighthouse, with additional pillars specialising in the sectors prioritised in the SRIDA to be updated in advance of the call publication, and complementing the previously selected projects.
- The selected proposals will maximise the coverage of the portfolio.

These networks will also address a number of sector- or societally-driven challenges, mobilising the community towards achieving common goals in addressing such challenge that AI, data and robotics can help solving, demonstrating the potential positive impact on the society, economy and environment.

To ensure a balanced portfolio and maximise the range of approaches and sectors, grants will be awarded to applications not only in order of ranking but also addressing complementary research or sectors, provided that the applications attain all thresholds.

Composition of the Network:

- Leading researchers in AI and AI relevant technologies from major excellent research centres, bringing the best scientists across Europe, including from promising research labs. They will bring on board the necessary level of expertise and variety of disciplines and profiles to achieve their objectives, ensuring a multidisciplinary and multi-sectorial research approach, while respecting equality and diversity among the attracted talents.
- Demonstrate access to the required resources and infrastructure to support R&D, such as cloud and computing capacity, IoT, robotics equipment, support staff and engineers, where relevant, to develop prototypes, pilots, demonstrators, etc.

Activities of the Networks:

- In order to structure the activities, the proposals will focus on important scientific or technological challenges with industrial and societal relevance where Europe will make a difference, by building on strengths, or strengthening knowledge to fill gaps critical for Europe.
- Based on the identified challenges, the proposals will develop and implement common research agendas. The main vision and roadmap with targets within the projects, as well

as methodology to implement and monitor progress will have to be specified in the proposal and can be further developed during the project.

- Scientific progress will have to be demonstrated through testing on application specific datasets or use-cases. By extending the benchmarking of foundational research to application specific areas, the research community will simultaneously address advancements in AI and grand societal and technological challenges.
- The proposals should define mechanisms to foster excellence throughout Europe, to increase efficiency of collaboration, including through networking and exchange programmes, and to develop a vibrant AI network in Europe.
- Each network will disseminate the latest and most advanced knowledge to all the academic and industrial AI laboratories in Europe and involving them in collaborative projects/exchange programmes. (This could involve projects defined initially or via financial support to third parties, for maximum 20% of the requested EU contribution).
- Each network will develop, where relevant, interactions with the industry, in view of triggering new scientific questions and fostering take-up of scientific advances
- Each network will develop collaboration with the relevant Digital innovation Hubs and AI start-up initiatives, to disseminate knowledge and tools, and understand their needs.
- These networks should also foster innovation and include mechanisms to exploit new ideas coming out of the network's work (for instance via incubators).
- Overall, each proposal will define mechanisms to become a virtual centre of excellence, offering access to knowledge and serve as a reference in their chosen specific field, including activities to ensure visibility.

The proposals should

- include mechanisms to spread the latest and most advanced knowledge to all the AI-labs in Europe
- develop synergies and cross-fertilization between industry and academia
- become a common resource and shared facility, as a virtual laboratory offering access to knowledge and expertise and attracting talents
- provide broad access to AI excellence in Europe and also play an important role in increasing visibility

The proposals should include a number of major scientific and application challenges which will mobilise the community to join forces in addressing them. Continuous evaluation and demonstration of scientific and technological progress (with qualitative and quantitative KPIs, benchmarking and progress monitoring processes) towards solving the targeted challenges will motivate the entire network and support publications and scientific career developments

(providing references to publish comparative results, using the reference data, scenarios, etc.), and also showcase the technology in application contexts, to attract more user industries and eventually foster take up and adoption of the technology.

Activities are expected to achieve at least TRL 4 by the end of the project.

The proposals are expected to include mechanisms to share resources, knowledge, tools, modules, software, results, expertise, and make equipment/infrastructure available to scientists to optimise the scientific and technological progress. To that end, proposals should exploit tools such as the AI-on-demand platform¹⁵⁹ and further develop and expand the platform, to support the network and sharing of resource, results, tools among the scientific community, maximising re-use of results, and supporting faster progress. Mechanisms to test results and continuously measure and demonstrate progress should be integrated in the platform, which is also important to support the scientific community, allowing also for comparative analysis. The proposals are also expected to include collaboration mechanisms among the best AI and AI-relevant research teams, but also mechanisms to bring all European AI teams to the highest level of excellence. This is also in view of supporting and encouraging the adoption of AI technologies in all Member States, with particular emphasis on geographical aspect and elimination of gaps between Member States, as well as addressing existing gender disparities.

Proposals will also exploit and develop technology enablers, such as methodologies, tools and systems and exploit latest hardware development and data spaces, cloud and HPC resources.

To ensure a balanced portfolio grants will be awarded to applications not only in order of ranking but the highest ranked in the each research focus, provided that the applications attain all thresholds.

Proposals are expected to develop synergies with relevant activities in AI, Data and robotics, primarily in destination 3, 4 and 6, but also in other destinations and clusters (in particular with cluster 3 regarding security-related activities), and share or exploit results where appropriate.

An Internet of Trust

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-HUMAN-01-03: Internet architecture and decentralised technologies (RIA)

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

¹⁵⁹ Initiated under the AI4EU project <https://cordis.europa.eu/project/id/825619> and further developed in projects resulting from H2020-ICT-49-2020 call

<i>project</i>	this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- A greener, more secure and resilient global Internet based on a decentralised architecture stemming from the evolution of TCP/IP and the advent of distributed ledger technologies (DLT) and Blockchain.
- Increased European competitiveness and strategic autonomy in core internet technologies, DLT and Blockchain, reinforcing the European Internet and Blockchain ecosystems and excellence in research and innovation.
- A European ecosystem of top internet and Blockchain innovators, with the capacity to set the course of the Internet evolution and strengthening the role of Europe in Internet standard setting.
- New business and sustainability models based on decentralised technologies and open source.

Scope: The Internet architecture has developed as a mix of centralised, networked and device-based technologies with design choices largely coming from the past. In particular, the questions of security and energy consumption were relatively secondary in the initial architecture design of the Internet. At the same time, ever-larger fractions of the internet as we know it today are operated by a relatively small number of platforms controlling end-users' data and online transactions, effectively leading to a centralisation of the Internet.

The first aim of this topic is to review and upgrade the Internet architecture (hardware, software, protocols) to propose more decentralised approaches, to increase the performance of the network, adapt it to new application requirements, make it more resilient to security threats, more energy efficient and respectful of the environment (e.g. recyclability), and increasingly supportive of open and decentralised technologies and services, such as Blockchain and DLT.

The topic will also address the current limitations of decentralised technologies, such as those related to scalability, interoperability, energy efficiency, privacy or security, in order to make them dependable building blocks of the future Internet. It will explore DLT-based solutions, enabling the exploitation of data coming from a high number and various types of sources, eliminating data silos through decentralised and interoperable approaches, while helping individuals and organisations to better govern their data when they participate in joint value

chains where cooperating partners can also be competitors. Such solutions should ensure a high level of trust for what concerns data provenance and authentication with [real-time] traceability, data integrity, data exploitation as well as data protection and privacy when it relates to individuals.

The focus is on advanced research that is linked to new technology breakthrough and/or relevant use cases. Apps and services that innovate without a research component are not covered by this topic.

Projects funded under this topic should include standardisation activities to promote the technologies developed in international standard setting organisations.

The projects should support open source software and open hardware design, including how to maintain key open source building blocks of the internet, access to testing and operational infrastructures, as well as an IPR regime ensuring lasting impact and reusability of results.

Financial support to third parties

For grants awarded under this topic for Research and Innovation actions beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants.

Each RIA will support third party projects from outstanding open source innovators, academic research groups, high-tech startups, SMEs and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to building a more decentralised and trustworthy Internet. As the primary purpose of the action is to support and mobilise internet innovators, a minimum of 80% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The consortium will provide the programme logic for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain, including in terms of standardisation. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract top internet and DLT talents, to deliver value-added services to the third-party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently and efficiently (a minimum of five open calls during the lifetime of the project). They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring

focused effort, third parties will be funded through projects typically in the EUR 50 000 to 200 000 range per project, with indicative duration of 9 to 12 months.

HORIZON-CL4-2022-HUMAN-01-05: A safer Internet (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- AI tools and technologies (including classifiers) to identify digital Child Sexual Abuse Material (CSAM).

Scope: One of the main challenges in the fight against online CSAM is the vast amount of potential new CSAM that Hotlines and LEAs have to assess and classify as illegal prior to takedown. In 2018, for example, national LEAs in the EU received more than 500,000 referrals stemming from US internet providers, while INHOPE Hotlines are seeing increasing numbers of reports of CSAM hosted in the EU resulting from proactive search for CSAM. Relying on human analysts alone to assess such vast quantities of material slows up both law enforcement investigations and notice and takedown actions. There is therefore an urgent need to further develop and test AI tools which support the classification of CSAM. Such AI classifier tools will help law enforcement agencies (LEAs), INHOPE Hotlines, and industry to analyse the vast amounts of digital CSAM more efficiently through automated identification and prioritization, thus leading to swifter takedown of illegal material by Hotlines and industry, and more effective investigations by LEAs.

The projects shall aim to develop mature tools that support the analytical work of LEAs and Hotlines, based on relevant classifiers that correspond to typical elements/characteristics of CSAM. The tools shall allow identification, categorisation and prioritisation of digital CSAM from large data sets. The solutions should be robust enough and provide sufficient information to help Hotline analysts and law enforcement officers in their assessments.

To ensure that the proposed solutions are fit for purpose and effective, INHOPE Hotlines and LEAs shall be involved in each project. Working in close cooperation with them, the projects shall build on existing infrastructures and processes already available to LEAs and INHOPE

Hotlines. The projects shall ensure European added value through cross-border interoperability.

The projects shall define the characteristics and granularity of classifiers required, develop the classifiers, compose and annotate representative CSAM data sets, train and test the tools in cooperation with LEAs and INHOPE Hotlines. As CSAM is illegal, these data sets need to be provided by or composed mainly in cooperation with LEAs. To reduce the development and training time on this sensitive data, the proposed tools should be able to incorporate dynamically user feedback, preferably without the need of retraining the model. The proposed tools should also allow pre-training on data available for other general tasks, like image classification, object detection, instance segmentation, etc., in order to increase the accuracy and to reduce the exposure to sensitive data during training. The tools to be developed can also include other relevant features such as text-based data analysis, audio analysis from videos and/or automated key word extraction from audio or age detection.

All tools developed throughout the projects shall be made freely available as Open Source Software, also for industry to use on a voluntary basis to detect and remove illegal material.

The topic, with its focus on more effective and efficient AI-based tools for processing online CSAM by a wide range of actors (NGOs, industry, Law enforcement), complements the objectives of Horizon Europe [Cluster 3 Civil Security for Society](#)¹⁶⁰, which will advance research into perpetrators and on tools for law enforcement intelligence. Moreover, it will build on relevant work performed in previous EU-funded projects and national initiatives.

HORIZON-CL4-2022-HUMAN-01-07: NGI International Collaboration - USA (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Enhanced EU-US cooperation in the development of Next Generation Internet technologies, services and standards.

¹⁶⁰ HORIZON-CL3-FCT-2021-01-11: Child sexual exploitation prevented

- Supporting the EU internet policy objectives by sharing the EU vision and values with US counterparts and forging bonds through concrete collaborations.
- An EU-US ecosystem of top researchers, hi-tech startups / SMEs and Internet-related communities collaborating on the evolution of the Internet according to a human-centric approach.
- Generate new business opportunities for European Internet innovators based on decentralised technologies and open source.

Scope: The aim of the topic is to reinforce EU-US cooperation and strategic partnerships in the area of Next Generation Internet, and to establish a continuous dialogue among the actors involved in the US and EU programmes, in particular as far as internet standardisation is concerned. The focus will be on trust and data sovereignty and on internet architecture renovation and decentralised technologies.

A RIA will organise joint projects by EU and US teams on emerging topics for the EU Next Generation Internet and corresponding US programmes, including technology development, joint demonstrators and joint contributions to standards. Proposals shall foresee twinning with entities participating in projects funded by the US. The project should support open source software and open hardware design, open access to data, standardisation activities, access to testing and operational infrastructures as well as an IPR regime ensuring lasting impact and reusability of results.

Financial support to third parties

For grants awarded under this topic for Research and Innovation actions, beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants.

Each RIA will support third party projects, from open source developers, to academic researchers, hi-tech startups, SMEs and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to enhancing EU-US cooperation in the development of Next Generation Internet technologies and services. As the primary purpose of the action is to support and mobilise internet innovators, a minimum of 80% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The consortium will provide the programme logic for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain and in advancing EU-US collaboration. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract top internet talents, to deliver value-added services to the third-party projects, as well as their

expertise and capacity in managing the full life-cycle of the open calls transparently and efficiently. They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties will be funded through projects typically in the EUR 50 000 to 100 000 range per project, with indicative duration of 9 to 12 months.

HORIZON-CL4-2022-HUMAN-01-08: NGI International Collaboration - Canada (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

Expected Outcome:

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

- Enhanced EU-Canada cooperation in the development of Next Generation Internet technologies, services and standards.
- Supporting the EU internet policy objectives by sharing the EU vision and values with Canadian counterparts and forging bonds through concrete collaborations.
- An EU-Canada ecosystem of top researchers, hi-tech startups / SMEs and Internet-related communities collaborating on the evolution of the Internet according to a human-centric approach.
- New business opportunities for European innovators based on decentralised technologies and open source.

Scope: The aim of the topic is to reinforce EU-Canada cooperation and strategic partnerships in the area of Next Generation Internet, and to establish a continuous dialogue among the actors involved in the Canadian and EU programmes, in particular as far as internet standardisation is concerned. The focus will be on trust and data sovereignty, in particular digital identity, and on internet architecture renovation and decentralised technologies.

A RIA will organise joint projects by EU and Canadian teams on emerging topics in the area of Next Generation Internet, including technology development, joint demonstrators and joint contributions to standards. The project should support open source software and open hardware design, open access to data, standardisation activities, access to testing and operational infrastructures as well as an IPR regime ensuring lasting impact and reusability of results.

Financial support to third parties

For grants awarded under this topic for Research and Innovation actions, beneficiaries should provide support to third parties. The support to third parties can only be provided in the form of grants.

Each RIA will support third party projects, from open source developers, to academic researchers, hi-tech startups, SMEs and other multidisciplinary actors, so that multiple actors are funded and collectively contribute to enhancing EU-Canada cooperation in the development of Next Generation Internet technologies and services. As the primary purpose of the action is to support and mobilise internet innovators, a minimum of 80% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The consortium will provide the programme logic for the third-party projects, ensure the coherence and coordination of these projects, and provide the necessary technical support, as well as coaching and mentoring, in order to ensure that the collection of third party projects contributes to a significant advancement and impact in the research and innovation domain and in advancing EU-Canada collaboration. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries shall make explicit the intervention logic for the area, their capacity to attract top internet talents, to deliver value-added services to the third-party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently and efficiently. They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

The Commission considers that proposals with an overall duration of typically 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations. For ensuring focused effort, third parties will be funded through projects typically in the EUR 50 000 to 100 000 range per project, with indicative duration of 9 to 12 months.

eXtended Reality (XR)

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-11: eXtended Reality Technologies (RIA)

Specific conditions	
<i>Expected EU contribution per project</i>	The EU estimates that an EU contribution of around EUR N/A million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
<i>Indicative budget</i>	The total indicative budget for the topic is EUR million.
<i>Type of Action</i>	Research and Innovation Actions
<i>Funding rate</i>	100%

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

- Innovative eXtended Reality industrial and societal applications, integrating technologies such as advanced visualisation, 3D, Augmented and Virtual Reality experiences, human-machine interaction and cooperation, with a focus on well designed and fully tested scenarios in real-world environment.

Scope: The emergence of smart cities and factories, autonomous cars and homes, intelligent appliances in conjunction with Virtual and Augmented Reality applications are opening new ways to live, work, care, learn, play and socialize. Whilst people, places and objects are being digitized and transferred into the virtual world and placed spatially and contextually, sensors are embedded into our environments and the objects around us. New digital interaction technologies are playing an essential role in this transformation by enabling us to interact naturally and intuitively with digital information in the physical world.

This topic asks for research and innovation proposals to develop and demonstrate novel eXtended Reality (XR) technologies, combining human-machine interactions and real, mixed, augmented and virtual environments, aiming to augment the capabilities of users and machines and to provide seamless and persistent physical-digital experiences, while guaranteeing the privacy and rights of individuals and companies and ensuring safe, secure and trustworthy interactions.

Special attention will be given to including end-users and transdisciplinary research including social sciences and humanities, in order to deliver and enhance uptake of suitable, ethical and safe solutions.

Proposals should cover at least one of the following points and will provide well designed and fully tested scenarios in real-world environment for enhanced eXtended Reality experiences:

- devising innovative digital interfaces that take advantage of spatial computing to allow users to interact with real-time contextual information activated by intuitive sensory triggers;

- developing novel multi-user virtual communication and collaboration solutions that provide coherent multisensory experiences and optimally convey relevant social cues;
- improving the robustness, accuracy and semantic understanding of the current mapping and positioning systems, while providing real-time bidirectional synchronisation between models and interactive applications;
- facilitating the exploitation of 3D data acquisition techniques, enhancing its performance while reducing technology costs and providing efficient and scalable encoding, processing, storage and rendering means;
- enabling the construction of compelling context-aware and embodied experiences by providing solutions for the creation of convincing digital avatars and agents, with natural looking and physically realistic behaviours, movements and expressions.

OTHER ACTIONS NOT SUBJECT TO CALLS FOR PROPOSALS

Grants to identified beneficiaries

1. New & Improved EUSST Missions and Services

Expected Outcomes:

In the coming years, an increase in the number of active objects in orbit is foreseen (e.g. deployment of mega-constellations, increased number of non-maneuvrable small objects – SmallSats for research and scientific purposes, etc.). Additionally, the number of objects (active and inactive) to be handled by SST systems will also increase due to the use of sensors with a higher detection capability. For example, the US Space Fence radar, declared operational in March 2020, is capable of detecting and tracking objects smaller than 10 centimetres and is expected to considerably increase the size of the space objects catalogue of the US Space Surveillance Network.

Consequently, the provision of services by the EUSST operation centres, as well as the strategy used to protect the European active satellites will have to be adapted to the arising needs. The need for the development of automated concepts becomes more relevant in order to reduce response times, reduce costs and simplify coordination activities amongst operators.

Therefore, R&I projects on “*new and improved EUSST missions and services*” are expected to contribute to the following outcomes:

- Keep the knowledge and capabilities of Europe on the Space Surveillance and Tracking domain at the leading edge.
- Adapt, improve and evolve the current EUSST initial services (Collision Avoidance; Fragmentation; Re-entry) portfolio to future user needs and space environment.
- Improve the overall performance of the EUSST services and ensure, in the long-term, a high level of performance and appropriate autonomy at Union level.
- Identify and define new missions and services (e.g. debris mitigation; debris remediation).
- Explore the implementation of new services, in complement of the three existing ones.
- Support the pre-developments and end-to-end early demonstration of new SST services.

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following:

- R&I on evolution of the Collision Avoidance service towards a higher responsiveness in the case of risks (e.g. Automatic warning service), and in all phases of the spacecraft life (e.g. deorbiting, EOL, etc.),
- R&I on evolution of the EUSST system for **debris mitigation** in order to reduce the space debris generation, as for example:
 - o Extended computation of conjunctions and risks;
 - o Automatic risk estimation and mitigation measures, (e.g. ground or on-board processes and using AI techniques);
 - o Support to satellite Owner / Operator in case of need: localisation of the spacecraft; spacecraft anomalies or on orbit contingencies; post-manoeuve support in order to check the manoeuvre went as planned, etc.
 - o In general, support to all phases of the spacecraft life, in order to facilitate the decision making of the O/O and contribute to debris mitigation purposes (guidelines/standards/rules compliance).
 - o Design of innovative solutions for the detection and characterisation of malfunctioning satellites;
 - o Development and on-ground demonstration of passivation technologies;
- R&I on evolution of the EUSST System for space **debris remediation** by managing the existing space debris. The analysis of potential remediation focused services at European level, the feedback of O/O and the monitoring of the international arena in the coming years are needed inputs prior to define the content of this topic in detail.
 - o Stimulation of the use of removal and disposal techniques through regulatory initiatives;
 - o Exploring the implementation of an Active Debris Removal (ADR) and on-orbit servicing (OOS) monitoring service, through attitude and relative orbit characterisation;
 - o Design associated to removal/servicing technology demonstration;
 - o Development and on-ground demonstration of disposal and active removal technologies;
- R&I on evolution of the EUSST Service Provision Portal in line with the evolution of the existing services (CA, RE, FG) and the inclusion of additional new ones (Debris mitigation / remediation). R&I activities will be required to cope with an expected increased number and heterogeneity of users and spacecraft, evolution of the SST Consortium/Partnership, etc. Reporting activities must continue evolving, as to provide

actionable “Key Performance Indicators” supported by the development of the necessary tools/applications.

[As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of [Articles 56 & 57 of the “Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme”], and under the same Regulation the [Member States] are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Legal entities:

The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195 - Research and innovation action

Indicative budget: EUR million from the 2022 budget

2. SST & STM system architecture and evolutions

Expected Outcomes:

The environment on which the EUSST system performs its mission and delivers its services is in constant evolution (e.g. technological or political factors changing the way on which the space is used, orbital environment ...).

EUSST system architecture engineering & evolutions: the analysis of the EU SST system architecture needs to continuously progress to evaluate how the system has to evolve at medium and long term, not only at network level (type, performance, number, geographical localisation... of assets) but also at data processing and at services level. Other aspects like data flow, security constraints, interconnectivity and complementarity between EU assets but also cooperation with other non-European SST systems, etc. need to be considered as well.

Therefore projects developed under this topic are expected to contribute to the following outcomes:

- Foster European cooperation in the SST domain and improve the EUSST performance towards larger autonomy.
- Highlight and propose solutions to fill the gaps in the current EUSST architecture.

- Pave the way on which the EUSST system has to evolve towards a higher level of performance (e.g. accuracy; number / size of catalogued objects...), quality of service (e.g. timeliness of information...) and autonomy.
- Demonstrate the complementarity, coherence and added-value of each element of EUSST system towards a more autonomous, interoperable SST system.
- Explore and look for higher levels of cooperation with other SST systems such as the US SSA system which is of paramount importance to develop long-term cooperation.

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following:

- EUSST architecture engineering.
- Define the future EUSST architecture and associated development roadmap offering the highest performance, European autonomy and best value for money
- Architecture studies and system design to validate the added-value of all the layers of the EUSST system.
- Define and set up efficient and relevant performance criteria, “metrics”, “Key Performance Indicators” and “critical success factors” (e.g. accuracy of European catalogue; false alarms ratio; expected increase of the number of objects into the catalogue; timeliness of service provision...)
- Improved SST system architecture simulation tools
- Activities / studies in the area of support to spacecraft manoeuvres, interference management, collision avoidance automation.
- Activities / studies in space objects life cycle and risk assessment.
- Assessment and pre-development of technology for rendez-vous and close proximity operations.
- Develop and promote spacecraft / constellations “Clean_design”.
- Assessment of added value of technologies for in-orbit servicing.
- Assessment and pre-development of technology for object identification, for navigation aids and for servicing interfaces.
- Support and prepare for technical standardisation activities in these areas.

[As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of [Articles 56 & 57

of the “Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme”], and under the same Regulation the [Member States] are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Legal entities:

The Constituting National Entities having concluded an agreement creating the SST partnership]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195 - Research and innovation action

Indicative budget: EUR million from the 2022 budget

3. Space-based SST (mission, system and sensors network)

Expected Outcomes:

With the increase of the orbital population and with the need of observing smaller objects to better protect the EU space assets, the need and added-value of developing Space-Based Space Surveillance (SBSS) missions in complement to ground SST networks shall be studied in Europe. Based on the experience of SBSS missions launched and operated outside Europe (e.g. by US and Canada), Space-based SST missions and sensors network will have to be included in EUSST in order to increase the EU ability to observe and catalogue objects on various orbits, and compensate for the limitation linked to the geographical location, light and weather conditions of ground sensors.

Therefore projects developed under this topic are expected to contribute to the following outcomes:

- Study and assess several technical solutions for the development of a future European capability of SBSS.
- Explore the use of small satellite solutions to reduce CAPEX and OPEX
- To develop in the mid-term the European capacity to operate independently SBSS.
- To reduce the dependence on critical SBSS technologies and capabilities from outside Europe,

Scope:

R&I activities which needs to be addressed in order to tackle the above expected outcomes are the following:

- Study of various mission configurations (e.g. orbit regime, orbit plan, ...) and payload location to maximize the number of observed and catalogued objects, and other performance targets such as e.g. improve observation of objects not well seen from Earth sensors, increase of number of observations, increase of the catalogue accuracy, etc). Analyse the EU SST gaps and the solutions that would address them with the best value for money,
- Study of coordination strategy and techniques among the satellites of the SBSS mission and the terrestrial SST system.
- Develop or improve existing algorithms allowing going from detection to cataloguing (e.g. IOD, correlation ...) taking into account ground based SST system and payload performance (i.e. observable magnitude).
- Exploration of the use of non-dedicated sensors (e.g. star trackers) or hosted payloads in non-dedicated missions ("opportunistic" solutions) to reduce cost of operation is also an aspect to develop.
- Security issues related to the link between SBSS and ground EUSST network.

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Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Legal entities:

The Constituting National Entities having concluded an agreement creating the SST partnership]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195 - Research and innovation action

Indicative budget: EUR million from the 2022 budget

4. SST Sensors and Processing

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

Supporting the upgrade and development of on-ground assets, in particular radars and telescopes as well as data processing.

SST radiofrequency & optical sensors (radars, telescopes...) technological research & innovation: due to the increased number of objects (both active and debris) to be handled, as well as the evolution and inclusion of services in the future, R&I activities are necessary in the sensor domain, both for radiofrequency (e.g. passive ranging, radars, etc.) and optical sensors (e.g. telescopes, lasers). New promising technologies like sensors based on the use of infrared will also be considered.

- Contribution to a consolidated and efficient EUSST sensor function.
- Improve coverage area, geographical location and performance they can offer: e.g. field of view, limiting magnitude, frequency-band, accuracy, timeliness of the associated processing ...
- Ensure an optimum evolution of the configuration and use of the EUSST sensors network, including the necessary raw data processing required to provide measurement data.
- Improved integration and connectivity of value added sensors, ensuring their compliance to the minimum quality requirements (including protocols, procedures, formats and calibration status).

SST data processing research & innovation (e.g. Artificial Intelligence...): the changes and evolution in the space environment impose the need of adapting the current algorithms and data processing methods and tools, as well as to look for new one.

- Include or at least explore the possibility to use Artificial Intelligence (AI) in any SST data processing (e.g. Improvement of object detection capability; of probability of collision accuracy ...)
- Development of automatic sensor scheduling and tasking, and data processing functions

Scope: To ensure that the sensors and data processing used in the SST domain can properly address the upcoming requirements in all aspects, the following R&I activities needs to be addressed in order to tackle the above expected outcomes:

- Adaptation to the new environment of technologies already in use in SST sensors like radars, telescopes and lasers.
- Improvement of sensors performances (e.g. measurements quality (noise; bias; measurements rates ...); tracks accuracy (track noise; track duration...)).

- Specification, development, testing and pre-integration of improved sensors.
- Innovations need to be developed to allow detection of smaller objects, higher processing capabilities (e.g. networked telescopes for LEO coverage, tracking by lasers in daylight ...).
- New detection strategies to cope with an increased number / size of objects in the sensors' Field of Regard / Field of View.
- Additionally, new technologies and/or processing algorithms and techniques will be explored for the development and implementation of potential new services developed in [SPACE-53-2022 *New & Improved EUSST Missions and Services*] topic (e.g. support to manoeuvre, detection of malfunctioning spacecraft, etc.)
- Improved algorithms (e.g. Measurements correlation, Initial Orbit Determination, OD, covariance estimation...) for a more agile and accurate cataloguing of the increasing space objects population and services provision (e.g. Collision avoidance, support to manoeuvres and identification of in-orbit anomalies, etc...).
- Improved algorithms for data fusion for a more efficient use of the data and information from the same object coming from different sensors.
- Improvement of computation models of collision probability.
- Development of evaluation methods of collision probability that could be applied to constellations (e.g. multiple encounters).
- Improvement or development of new objects propagation models for efficient propagation of the orbital population (e.g. cloud propagation models to propagate the debris cloud generated after a fragmentation ...).
- Evolution of coordinated scheduling and tasking of sensors to progress towards a more efficient use of multiple available resources at system level.
- Improved algorithms for objects characterisation.
- Any promising technology for precise tracking and data processing.

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Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Legal entities:

The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195
- Research and innovation action

Indicative budget: EUR million from the 2022 budget

5. SST Networking, Security & Data sharing

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

The topic “SST Networking, Security & Data sharing” aims to support the upgrade, development and security issues of EUSST infrastructure based on the European network of assets (sensors, operation centres, front desk ...).

Although the EUSST infrastructure is supposed to stay under national control (meaning mainly sensors and operation centres), an increased coordination is needed due to the increased number of assets contributing to the European SST system. Without this interconnection and coordination, it is impossible to ensure an efficient use of the resources and an appropriate response to the challenges posed by the changing space environment.

As concrete aspects of the EUSST network (e.g. pooling of data from multiple sensor sources; exchange between multiple operations centres of Member States) shall be considered in highly detailed case studies, modelling ..., this topic shall be limited to the members of the EU SST Consortium/Partnership in order to protect security-sensitive information.

SST networking of sensors & operation centres (EU SST network Command & Control): considering the increased number of objects to be handled, an increased number of events and users is expected. The European SST system has to evolve to a coordinated scheduling of the resources and assets, ensuring that the events are covered in an optimum way, while the current survey and tracking of the space objects population continues to be performed. Evolution of the European SST network includes the Front Desk in charge of the interaction with the users (users’ needs, monitoring of the service performance, etc.).

- Raise the main issues and propose relevant answers to the increasing complexity and missions constraints of the EUSST network.
- Connectivity and interface consolidation of network function between sensors / database / operating centres / front desk (reliability, maintainability and agility).
- Develop EUSST network in order to include a future new SBSS segment.

Research on EUSST network hardening against external threats: the research concerns security-critical aspects of the existing EU SST network. Various external threats shall be

considered in the research activity (e.g. cyber threats or other malicious activity). Research specifically applying to the hardening of the EU SST network could add value to existing research on network hardening that looks at computer networks and other related networks more generally.

- A secured and resilient EUSST infrastructure.

Next generation exchange protocols / solutions for SSA enhancing interoperability and security (robustness, information assurance, intrusion detection...)

- A secured and resilient EUSST infrastructure
- Define the need for SST-specific tools and solutions with regard to enhanced data interoperability and data security.

Scope: the following R&I activities need to be addressed in order to tackle the above expected outcomes:

- Update operation centres to improved current services (Collision Avoidance; Fragmentation; Re-entry) adapted to future user needs and space environment.
- Update operation centres to new missions and services (e.g. debris mitigation; debris remediation).
- Adapt the European SST network to a more efficient coordinated scheduling and tasking of the resources and assets.
- Develop new data sharing and fusion strategies and techniques adapted to both ground based and space based SST assets.
- Develop threats analysis and associated counter measures.
- Adapt EUSST operation centres for increasing security and resiliency.

[As the legal entities identified below are bodies designated by Member States, under their responsibility, to participate in the SST Partnership within the meaning of [Articles 56 & 57 of the “Regulation of the European Parliament and of the Council establishing the space programme of the Union and the European Union Agency for the Space Programme”], and under the same Regulation the [Member States] are identified as beneficiaries, this grant is awarded without a call for proposals in accordance with Article 195(d) of the EU Financial Regulation 2018/1046.

Legal entities: The Constituting National Entities having concluded an agreement creating the SST partnership

Legal entities:

The Constituting National Entities having concluded an agreement creating the SST partnership

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195
- Research and innovation action

Indicative budget: EUR million from the 2022 budget

Prizes

1. EIC Horizon and CASSINI Prize for digital space applications

Description:

The specific rules of the contest will be published in 2021 by the European Commission, which will delegate to a designated EU agency the task to launch and manage the contest and award the prize based on the judgement of independent experts. The indicative budget for the prize is EUR XX million from the 2022 budget.

Expected results:

The prize will be awarded to the best data-driven marine or maritime digital application. The application uses Copernicus and/or Galileo data in combination with other data sources, and aims at solving problems or meeting customer needs related to the monitoring and forecasting of marine and coastal environments, marine resources, Search and Rescue operations, offshore activities, and weather and climate change. The awarding of the prize is expected to leverage more private investment capital to the winning contestant.

Essential award criteria:

The prize will be awarded, after closure of the contest, to the contestants who in the opinion of the jury demonstrate a solution which is at least a system prototype demonstrated in an operational environment that best addresses the following cumulative criteria:

- A marine or maritime digital application, which uses Copernicus and/or Galileo/EGNOS data in combination with other data sources.
- The application may consist of a digital service, data processing and analytics tools, systems or subsystems, including artificial intelligence technology.
- The application creates significant benefits, in support of the objectives of the Green Deal, to an identified target group, by solving problems or meeting customer needs related to the monitoring and forecasting of marine and coastal environments, marine resources, Search and Rescue operations, offshore activities, and weather and climate change.
- The application is accompanied by a business model that makes it a viable and sustainable business proposition with users or customers among companies, authorities, organisations or individuals.

Eligibility criteria:

Companies incorporated as legal entities in one of the Member States of the European Union.

The reward (budget):

The indicative budget for the prize is EUR XX million from the 2022 budget, to be awarded to one/two winning contestant(s).

Indicative timetable of contest(s):

Stages	Date and time or indicative period
Opening of the contest	Q4 2021
Deadline for submission of application	Q2 2022
Award of the prize	Q3-Q4 2022

Form of Funding: Prizes

Type of Action: Inducement Prize

Indicative timetable: Q4 2021: Publication/contest opens, Q2 2022: Deadline to submit applications, Q3-Q4 2022: Prizes awarded.

Indicative budget: EUR million from the 2022 budget

2. EIC Horizon and CASSINI Prize for space technology products and services

Description:

The specific rules of the contest will be published in 2021/22 by the European Commission, which will delegate to a designated EU agency the task to publish and manage the contest and award the prize based on the judgement of independent experts. The indicative budget for the prize is EUR XX million from the 2022 budget.

Expected results:

The prize will be awarded to the best solution(s) for implementing an EU developed and manufactured reusable 1st stage using green propulsion for its microlauncher solution launched from EU territory. The awarding of the prize is expected to leverage more private investment capital to the contestants.

Essential award criteria:

The prize will be awarded to the contestant(s) whose proposed solution has been demonstrated in an operational environment. The solution should be at least a prototype and should best address the following cumulative criteria:

- Excellence;
- Technical implementation;
- Service sustainability.

Eligibility criteria:

Companies incorporated as legal entities in one of the Member States of the European Union or in a country associated to Horizon Europe¹⁶¹.

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union's strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only/and the following associated/third countries [add list of associated or other third countries. Proposals including entities established in countries outside the scope specified in the topic will be ineligible.

For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)]. Proposals including entities that are controlled by third countries outside the scope specified in the topic will be ineligible.

The reward (budget):

The indicative budget for the prize is EUR XX million from the 2022 budget, to be awarded to one winning contestant.

Indicative timetable of contest(s):

Stages	Date and time or indicative period
Opening of the contest	Q3-Q4 2021
Deadline for submission of application	Q2 2022
Award of the prize	Q4 2022

Form of Funding: Prizes

¹⁶¹ The prize relates to the development of European critical space infrastructure, which is of strategic importance and security-critical for the Union and its Member States. Therefore: (1) participation in this prize contest will be limited to legal entities established in EU Member States and Countries Associated to Horizon Europe; (2) the rules of contest will: (a) stipulate that a proposal may be rejected for security reasons; (b) provide further details on the obligation to develop and deploy the solution in an EU Member State

Type of Action: Inducement Prize

Indicative timetable: Q3-Q4 2021: Publication/contest opens, Q2 2022: Deadline to submit applications, Q4 2022: Prizes awarded.

Indicative budget: EUR million from the 2022 budget

Operating grants

Public procurement

1. Public Procurement for Business intelligence study on the technological maturity, technologies' market prospects, conditions and market concentration for enabling and emerging technologies

Expected Outcomes: Intended results of the action in a period of 1-2 years will be a number of data sets, connected indicators and related methodology on the amount and quality of R&D&I that the industry is investing in high potential emerging technologies and KETS for competitiveness and for reaching SDG goals.

Hence, analyses will provide data and conclusions based on comparisons with R&D&I investments by main competitors and based on comparisons with the minimum viable amounts of R&D&I in KETs and emerging high potential techs that are essential to tackle emissions and scarcity of resources.

Overall impact is to highlight strengths and weaknesses in private R&D&I in the EU as compared to other key global regions helping to develop with Member States and other stakeholders 'Common industrial technology roadmaps' under the European Research Area. This shall allow industry's technology proficiency, as shown in the analyses, playing a stronger role in the development of EU industrial policy, environmental and climate policy, external relations, international cooperative research, trade negotiations, etc..

Scope: To collect and analyse data from IP, balance sheets, annual reports, cutting-edge industrial experts and other documentation and any other sources to assess each industry's economic and technologic fitness, fitness of industries' value chains, market share and other related data, and their individual potential (specific indicators) in terms of addressing SDGs and in keeping European technologic and economic competitiveness. Focus will be on particular technologies after consultation with colleagues in the R&I family and after analysis of what are the priority areas that are set in the 'Destinations' in HE and Green Deal Call.

Timing: Q2, 2021

Duration: 48 months

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR 1.00 million from the 2021 budget

2. Extended Industrial R&D&I and Technologies Investment Monitoring and Assessment Facility - Monitoring and assessment of industrial R&D&I investment for SDG targets

Provision of a method, extended data and analysis for assessing industry's R&D&I investments to achieve 'Green Deal' and other Commission's priorities goals, to assess state of play in industrial innovation efforts undertaken by EU companies participating into strategic value chains in view of increasing competitiveness of EU industries in the areas of green and other technologies.

Expected Outcomes: Intended results of the action over a period of 4 years will be a methodology, a number of data sets and connected indicators to assess the amount and quality of R&D&I that the industry is investing in green techs and other critical industries addressing environmental, competitiveness and inclusiveness capacity targets.

Overall impact is to highlight strengths and weaknesses in private R&D&I in the EU as compared to other key global regions, e.g. helping to develop with Member States, EU industry and other stakeholders 'Common industrial technology roadmaps' under the European Research Area. This shall allow industry's technology proficiency as shown in the analyses playing a stronger role in the development of EU industrial policy, environmental and climate policy, external relations, international cooperative research, trade negotiations, FDI, etc..

The framework contract will support the setting up of a monitoring and assessment facility on industrial R&D&I investment data in the context of the Green Deal/Sustainable Development Goals and in the context of economic and technologic competitiveness of green-tech industries.

The facility should be complementary to the Industrial R&D Investment Scoreboard which provides a number of indicators and baseline analyses on top actors' corporate R&D intensity, type of invested technologies and economic strength.

Scope: Activities in the topic will build on a previous line of preliminary data and analyses provided for under the GLORIA II administrative agreement with the JRC. The activities will include a more in-depth analysis of the take up, use and provision of green technologies by industries involved in green and other technologies and of their systems as well as of in general more in depth analysis in other technologies. The activities will also include, for example, building synthetic indicators to measure the importance of industries overtime impact respectively on SDGs and on economic and technologic competitiveness.

Possible data types for collection and analysis could furthermore include economic, technologic and SDG targets positioning in all sectors of partnerships in green tech areas and related assessment of their level of priority. Possible data types would also include collection of consistent time series in all green technology main areas and calculating a new indicator showing the level of contribution of each green technology industry over time in reaching

SDG targets. A similar new indicator to the one for green tech will apply for the priority industries that are not in the green tech areas.

Relating to green technologies, the objective of this action is to build up a multiannual facility to extend the analysis to industries beyond the top actors and to add a number of specific indicators and analyses to the baseline ones that are part of the current administrative agreement between the JRC and DG R&I]. The facility will bring focus on climate and environment relevant industries and technologies and their sustainable competitiveness. Overall, compared to one-off studies, the action will aim for a more systematic, methodology based and continuous monitoring of industrial R&I agendas and investments relevant to achieve the Green Deal goals.

The extra indicators will address a more in depth analysis of green tech providers and user companies' economic and technologic competitiveness, innovation networks and value chains, as well as their fitness to address SDGs targets and in general the adoption of sustainable solutions by industry sectors and eco-systems. Based on the above, the action will as well provide dedicated statistical and qualitative analysis of Industrial R&D&I investment in view of addressing evolving policy needs with regard to deploying and measuring impact of R&D&I support actions. Apart from sustainable competitiveness issues, analysis will also address strategic autonomy and industrial leadership in value chains and eco-systems relevant for achieving the Green Deal goals.

Furthermore, for a complete picture, the above indicators will supply more information in particular to measure performance of step-change innovation and emerging KETS, start-ups and smaller companies, and give insight into the market for technologies feeding into the R&D process. As we rely on new and key enabling technologies to address global challenges, also technological sovereignty deserves attention in the analysis of strategic green tech areas and value chains.

Duration: 48 months

Form of Funding: Procurements

Type of Action: Public procurement

Indicative timetable: Q3 2021

Indicative budget: EUR 6.00 million from the 2021 budget

3. Simulation approaches for complex socio-economic systems

Expected Outcomes: Projects are expected to contribute to the following outcomes:

Provide the Commission with a granular social simulation tool to assess the impact of changes in consumer rights and fundamental rights. The agent-based computational model approach provides unique opportunities in an area where intangible assets are disproportionately relevant and as a result data from observable market prices will typically not allow the specification of testable research hypothesis. The artificially created environment of multi-

agent simulation tools can step into this void and fill the gap. The Commission will benefit from this tool for the assessment and ex-post evaluation of changes in individual rights in strategic market and non-market settings.

Indicative budget: EUR X million from the 2021 budget and EUR Y million from the 2022 budget.

(Note that this item is related in terms of scope (research methodology, modelling approaches and data strategies) with HUMAN-39-2022; however, the technical requirements for the public procurement will be informed by a specific need identified in the Commission work programme; indicatively, the procurement activity should be allocated around 20% of what is being allocated to HUMAN-39-2022.)

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

4. EGNSS Evolution: Mission and Service related R&D activities

The objective is to study potential new services, as well as the enhancement of already defined services, answering to new user needs and determine whether and how the EGNSS mission of Galileo and EGNOS shall be enlarged or complemented to answer these new user needs. This includes the preparation of contributions and technical analysis supporting the EU position in multilateral and bilateral working groups and meetings.

Actions under this area will cover the assessment of services improvements and of new services or capacities to be introduced, justifying the need, developing the service concept including with international partners when relevant, assessing costs to the programme versus benefits to users and defining the roadmap of activities until an operational service could be provided.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

5. EGNSS Evolution: Operation and service provision related R&D activities

To design and validate the provision scheme of new services, the development of service demonstrators for EGNOS and for all services of Galileo (including PRS) will be required. Service demonstrators enable early simulation of new service concepts at early stages of maturity, supporting the definition of the mission requirements. These activities will contribute to the decision of whether to implement a new service, providing initial feedback

from future potential users on the various options considered and on the service provision requirements. In addition, the improvement of the complex operations is essential to improve the performance of EGNSS services. Likewise, maintenance activities must be subject to a continuous improvement process to guarantee the service continuity.

Actions under this area will cover the development and use of service demonstrators to consolidate the future EGNSS services, the optimization of the operation schemes using advanced dynamic strategies (e.g. machine learning) for Galileo constellation / system management for the efficient and continuous provision of the full portfolio of Services in EGNOS and in Galileo, and others.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

6. EGNSS Evolution : Technology and infrastructure-related R&D activities

Actions under this area will cover the maturing of the existing technologies and the development of new and emerging technologies, the engineering activities for the further evolution of Galileo and EGNOS existing systems, technical studies for the assessment of exploratory system concepts and/or responding to new mission needs and a changing environment, the development and maintenance of state-of-art system tools and technical test-beds, the implementation of actions agreed at Programme level to reduce the dependence of the supply chain on non-EU markets, the definition, design, development and implementation of experimental satellite demonstrator, and others.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

7. Support European “New Space” entrepreneurship through CASSINI Space Entrepreneurship Initiative 2021-2027

Scope:

1. CASSINI Business Accelerator: Boost business development of startup companies, increase early-stage revenue growth and raise venture capital.
2. CASSINI Hackathons & Mentoring: Innovation competitions to stimulate new ideas and prototypes based on data from Copernicus and EGNOS/Galileo.

Action 1: CASSINI Business Accelerator (SPACE-63-2021)

Implementation: the action will be implemented by the Commission through a call for tender in 2021 to select a consortium of European business accelerators and sign a service contract. At a later stage the action is due to be delegated to EUSPA.

Amount: The call for tender for Business Accelerator will be made in 2021 and the budgetary commitment of [] from Horizon Europe to be made in **2021** for a two-year contract with a two-year option for extension.

Expected Outcomes:

- The aims are to promote commercial use cases for the EU's space programme by providing qualified business development support. The objective is to increase the number of space-based companies that achieve high revenue growth. This will allow the companies to attract investments and capture new market shares.
- The expected economic benefits include an increase in the number of successful start-ups and scale-ups using space data and space technology, through an increase in sales, market share growth and staff hiring. These outcomes will allow the companies to attract larger amounts of financing through bank loans and equity investments.

Action 2: CASSINI Hackathons & Mentoring (SPACE-64-2022)

Implementation: the action will be implemented by the Commission through a service contract 2021-2023 concluded in 2020 under the existing Copernicus Framework Contract. The task will be delegated to EUSPA in 2022 for the activation of the two-year extension of the contract. Following the end of this service contract, the action will be subject to a new call for tender funded by Horizon Europe under delegation to EUSPA (2024).

Amount: The contract for Year 1 of Hackathons & Mentoring will be a commitment of [] on the 2020 DG DEFIS Space Programme budget, and to activate the extension for Year 2+3 a commitment of [] will be made on the **2022 budget of** Horizon Europe. The contract is awarded to the contractor [XXXXXXXXXX].

Expected Outcomes:

- To stimulate the spur-of-the-moment development of innovative applications based on data and information coming from Copernicus satellite images and EGNOS and Galileo positioning signals and services.
- To develop prototypes further into viable business propositions.
- To provide training opportunities on how to access and use data from Copernicus and EGNOS/Galileo with data analytics tools and artificial intelligence.
- To promote the EU's space programmes Copernicus and EGNOS/Galileo to a broader audience.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

8. Space Weather

Commonly occurring space weather events (SWE) have the potential to affect the performance of critical space and ground infrastructure by disrupting operations and communications in multiple sectors of society. In addition, “extreme SWE” could have devastating societal and economic consequences with potential costs for disruptions and damages estimated in tens or even hundreds of billions of Euros. Space weather technological research for new precursor services: the worldwide goal of space weather activities should be to monitor and forecast SWE just like terrestrial weather. However, direct physical simulation is currently not achievable for an operational Sun to Earth system, due in part to the lack of measurements and to the complexity of the involved processes, as well as different timescales involved. Current space weather models are generally not capable of forecasting events over several days. A longer forecasting horizon would require access to data from new observation infrastructure coupled with new and improved modelling capabilities. Research and innovation activities shall address application domains that may include space as well as terrestrial infrastructure. Proposals shall include architectural concepts of possible European space weather services in relation to the application domains addressed and they shall demonstrate complementarity to Space Weather services developed through the Space Situational Awareness component of the EU Space Programme.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2022 budget

9. Near Earth Objects

It is fundamental to improve our understanding of Near-Earth Objects (NEOs) through scientific modelling as well as the development of spacecraft instruments and data exploitation, both for the design of asteroids impact mitigation missions and the assessment of the associated effects, including those of large NEOs impact on the ground.

At present, our knowledge of the physical characteristics of the NEO population is limited. In order to conduct spacecraft close proximity operations to NEOs and undertake mitigation demonstration missions, it is necessary to have a number of specific technologies and instruments readily available to conduct missions to asteroids with very weak gravitational fields. In addition, ground-based observations also represent an essential means to investigate the physical and dynamical properties of the NEO population as a whole, thus leading to further strengthening the science return of a mission, as well as optimising the choice of mission targets.

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2022 budget

10. In Orbit Demonstration/Validation (IOD/IOV) service

To ensure EU non-dependence and competitiveness in technologies, there is a clear need for a regular, sustainable, cost-effective and responsive In Orbit Demonstration/Validation (IOD/IOV) service in the EU. Space flight heritage in real conditions and environment is often required to de-risk new technologies, products, concepts, architectures, services and operations techniques be that for unique or recurrent, institutional or commercial missions.

Intended results of the action is to provide a service for regular aggregation (if needed), launch and operations in orbit for IOD/IOV experiments; the objective is to have at least one opportunity every year during the Horizon Europe implementation period. This will contribute to reduce the time to market or operational use of new technologies, products, concepts, architectures, and operations techniques.

The IOV/IOV activities intend to provide a regular and cost-effective service and solution for common flight ticket actions (management, spacecraft design including reuse of existing solutions, assembly, integration and tests, launch and operations) based on EU solutions both for the spacecraft (i.e. platform, experiments aggregation, operations in orbit including preparation and associated Ground Segment) and for the launch services.

The actions will be selected through a call for expression of interest for IOD/IOV experiments, an analysis of the results in regards to a set of criteria (e.g. technical fit, policy relevance, programmatic fit, complementarity with other existing/planned actions) and if necessary by a preliminary feasibility. It shall be noted that experiments will have to bear the costs of their own development up to and including the flight models.

The scope of the activities includes mission design, integration and implementation, for all the necessary tasks to prepare, provide and operate spacecraft(s), together with the related ground segment, which accommodates the selected IOD/IOV experiments as well as the associated launch services.

For the aggregation and operations, the activities include:

- System studies, at ground and space level, including the compatibility with the available launchers;
- Input to the launch mission analysis performed by the launch service provider;
- Selection, assembly, integration and testing of the spacecraft(s) and related ground segment;

- Management of interfaces with and between the different IOD/IOV experiments, between the spacecraft and the launcher and between the spacecraft and the ground segment;
- Preparation of the spacecraft(s) for the flight;
- In-orbit testing and operations including data provision.

Concerning launch aspects, IOD/IOV activities shall support the European launcher exploitation policy, therefore relying on EU manufactured launcher solutions launched from territory. The actions will include the provision of flight opportunities with EU manufactured launchers which encompass the mission analysis, the verification of interfaces between the spacecraft and the launcher, the preparation of launch campaign and the flight up to the injection of the spacecraft(s) on the required orbit(s).

“In order to achieve the expected outcomes, and safeguard the Union’s strategic assets, interests, autonomy, or security, namely [describe outcomes and policy justification that raises concerns for the Union’s strategic assets, interests, autonomy, or security], participation to the call is limited to legal entities established in Member States [only / and the following associated/third countries [add list of associated or other third countries].”

“For duly justified and exceptional reasons [specify duly justified and exceptional reasons that warrant exclusion], in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in a Member State or in countries associated to Horizon Europe that are directly or indirectly controlled by third countries not associated to Horizon Europe or by legal entities of non-associated third countries, are [not eligible to participate or eligible to participate subject to the following conditions: (list of conditions)].

Form of Funding: Procurements

Type of Action: Public procurement

Indicative budget: EUR million from the 2021 budget and EUR million from the 2022 budget

11. Digital Assembly Events 2021 and 2022

DG CONNECT is organising the Digital Assembly Events 2021 and 2022. DG CONNECT plans to procure via Framework Contracts and call for tenders for indicatively 15 contracts before the end of 2022. The events are expected to take place in the 2nd calendar quarter of 2021 and in the 2nd calendar quarter of 2022. The call for tenders are expected to be launched on the 1st and 2nd calendar quarter of 2021 and 2022.

Indicative timetable: Q2 2021 and Q2 2022

Form of Funding: Procurements

Type of Action: Public procurement

12. ICT conferences, outreach, studies and other activities

In addition to calls for proposals, other actions are also expected to be undertaken on specific activities that the DG CONNECT will support. These include:

- The organisation of one ICT conferences (2022) and the organisation of an ICT proposers' day in 2021. DG CONNECT plans to conclude service contracts in 2021 and 2022, and also use existing Framework Contracts for this purpose. The events are expected to take place in the 4th calendar quarter of 2021 and 4th Calendar quarter of 2022. Indicative budget in 2022: EUR xx million. Indicative budget in 2021: EUR zz million. DG CONNECT plans to procure via framework contracts and calls for tender for a total of indicatively 40 contracts before the end of 2022 for the two events, depending on the operational needs. The calls for tenders are expected to be launched in the 1st calendar quarter of 2021 and 2022 respectively.
- Studies including socio-economics and impact analysis studies and studies to support the monitoring, evaluation and strategy definition for the ICT priority of Cluster 4 in Horizon Europe. DG CONNECT plans to procure via framework contracts and calls for tender indicatively 60 study contracts before the end of 2022. The calls for tenders are expected to be launched in the 2nd and 3rd calendar quarter of 2021 and 2022. It should be noted that internal outsourcing of studies to other Commission departments based on Administrative Agreements can be used as an alternative to the public procurement. Indicative budget in 2021: EUR xx million. Indicative budget in 2022: EUR xx million.
- Policy support activities, including benchmarking activities, evaluation and impact assessments, the development of ad hoc support software, possibly using existing Framework Contracts. DG CONNECT plans to procure via framework contracts and calls for tender indicatively 15 contracts before the end of 2022. The calls for tenders are expected to be launched in the 2nd and 3rd calendar quarter of 2021 and 2022. It should be noted that internal outsourcing of studies to other Commission departments based on Administrative Agreements can be used as an alternative to the public procurement. Indicative budget in 2021: EUR xx million. Indicative budget in 2022: EUR xx million.
- Publications and support to other events (e.g. information, communication, dissemination etc.), either through the use of existing Framework Contracts, or the launch of indicatively 25 calls for tenders during 2021 and 2022. The calls for tenders are expected to be launched in the 2nd and 3rd calendar quarter of 2021 and 2022. Indicative budget in 2021: EUR xx million. Indicative budget in 2022: EUR xx million.

Details will be provided in the texts of these calls for tender.

Form of Funding: Procurements

Type of Action: Public procurement

13. EUROSTAT¹⁶²

EUROSTAT subvention for benchmarking ICT Take up by households and by enterprises.

Eurostat, on the basis of co-delegation, will coordinate the Households and Enterprises surveys that will be conducted by the national statistical institutes and other competent national authorities of the Member States and Associated Countries where appropriate.

Legal entities: To perform these surveys, grants will be awarded to the national statistical institutes¹⁶³ and other competent national authorities in accordance with Article 5 of Regulation (EC) No 223/2009 on European Statistics.

Form of Funding: Procurements

Type of Action: Public procurement

Blending operations

Other budget implementation instruments

1. Expert Contracts for New indicators for the Green Deal and EU industry sustainability and competitiveness

Expected Impact

Intended results of the action over a period of 4 years will be a number of data sets and connected indicators on the amount and quality of R&D&I that the industry is investing in green techs and other strategically important industries addressing environmental, competitiveness and inclusiveness capacity targets.

Overall impact is to highlight strengths and weaknesses in private R&D&I, including patenting activity, in the EU as compared to other key global regions, to allow industry's technology proficiency as shown in the analyses playing a stronger role in the development of EU industrial policy, environmental and climate policy external relations, international cooperative research, trade negotiations, FDI, etc..

Scope

A climate-neutral economy 2050 and open technological autonomy require a new set of data to plan, monitor and evaluate the effectiveness of policy measures and industrial investments in R&I.

¹⁶² This grant will be awarded without call for proposals in line with Article 190(1)(e) of the Rules of applications of Regulation (EU, Euratom) 966/2012, Regulation No 1268/2012 and Article 11(2) of the Rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)", Regulation (EU) No 1290/2013

¹⁶³ In line with Regulation (EC) No 808/2004 of the European Parliament and of the Council of 21 April 2004 concerning Community statistics on the information society (OJ L 286, 31.10.2009, p. 31) and Regulation (EC) No 223/2009 of the European Parliament and of the Council of 11 March 2009 on European statistics (OJ L 87, 31.3.2009, p.164).

While the Industrial R&D Investment Scoreboard provides data on 2500 R&I leaders worldwide and 1000 in Europe, it does not include data on investments into R&I in distinct areas like decarbonisation, climate mitigation or other sustainability technologies. It needs to be complemented by indicators for industrial R&I competitiveness and resilience, to systematically provide the relevant data to inform EU policy as well as industrial decisions.

Type of Action: Individual Contractual Experts and/or Group of Experts [Not concerned by Decision C(2016)3301]

Duration: 48 months

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative timetable: Q1 2021

Indicative budget: EUR 1.00 million from the 2021 budget

Scientific and technical services by the Joint Research Centre

1. Scientific and technical services by the Joint Research Centre

Form of Funding: Direct action grants

Type of Action: Direct action grant for scientific and technical services by the Joint Research Centre

Indirectly managed actions

Budget¹⁶⁴

	Budget line(s)	2021 Budget (EUR million)	2022 Budget (EUR million)
Calls			
HORIZON-CL4-2021-TWIN-TRANSITION-01			
HORIZON-CL4-2022-TWIN-TRANSITION-01			
HORIZON-CL4-2021-RESILIENCE-01			
HORIZON-CL4-2021-RESILIENCE-02-PCP			
HORIZON-CL4-2022-RESILIENCE-01			
HORIZON-CL4-2021-DATA-01			
HORIZON-CL4-2022-DATA-01			
HORIZON-CL4-2021-DIGITAL-EMERGING-01			
HORIZON-CL4-DIGITAL-EMERGING-2022-01			
HORIZON-CL4-2021-SPACE-01			
HORIZON-CL4-2021-SPACE-02			
HORIZON-CL4-2022-SPACE-01			
HORIZON-CL4-2022-SPACE-02			
HORIZON-CL4-2021-HUMAN-01			
HORIZON-CL4-2022-HUMAN-01			
Other actions			
Grant to identified beneficiary according			

¹⁶⁴

The budget figures given in this table are rounded to two decimal places.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2021 and 2022.

Horizon Europe - Work Programme 2021-2022
Digital, Industry and Space

to Financial Regulation Article 195	<i>from</i> <i>01.020240</i>		
Prize			
	<i>from</i> <i>01.020240</i>		
Public procurement		7.00	
	<i>from</i> <i>01.020240</i>	7.00	
Expert contract action		1.00	
	<i>from</i> <i>01.020240</i>	1.00	
Direct action grant for scientific and technical services by the Joint Research Centre			
Estimated total budget		8.00	