EN

Horizon Europe

Work Programme 2021-2022

7. Digital, Industry and Space

(European Commission Decision C(2021)9128 of 15 December 2021)

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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, creates new products and services, and are central to any sustainable future. The COVID-19 pandemic 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 and guaranteeing security of supply.

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. Europe must develop and deploy technologies and reshape its industries and services towards a new reality, ensuring that industry can become the accelerator and enabler of this necessary change. Therefore the European Commission, in 'Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery',[1] supported the European Green Deal and the Circular Economy Action Plan, alongside the digital strategies 'Shaping Europe's Digital Future', 'Data', 'Artificial Intelligence' White Paper, Digital Decade Communication and 'Space Strategy for Europe'.

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 proposed investments under Cluster 4 are targeted to realise the overarching vision a of Europe that shapes competitive and trusted technologies for a European industry with global leadership in key areas by enabling production and consumption respecting 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.

Horizon Europe is the research and innovation support programme in a system of European and national funding programmes that shares policy objectives. Through the programme, special attention will be given to ensuring cooperation between universities, scientific communities and industry, including small and medium enterprises, and citizens and their representatives, in order to bridge gaps between territories, generations and regional cultures, especially caring for the needs of the young in shaping Europe's future. Calls could be EU Synergies calls, meaning that projects that have been awarded a grant under the call could

[1] 'Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery', COM(2021)350 final

have the possibility to also receive funding under other EU programmes, including relevant shared management funds. In this context, applicants should consider and actively seek synergies with, and where appropriate possibilities for further funding from, other R&I-relevant EU, national or regional programmes (such as ERDF , ESF+ , JTF , EMFF , EAFRD and InvestEU), where appropriate, as well as private funds or financial instruments. The ERDF focuses amongst others on the development and strengthening of regional and local research and innovation ecosystems and smart economic transformation, in line with regional/national smart specialisation strategies. It can support investment in research infrastructure, activities for applied research and innovation, including industrial research, experimental development and feasibility studies, building research and innovation capacities and uptake of advanced technologies and roll-out of innovative solutions from the Framework Programmes for research and innovation through the ERDF.

The EU's Recovery and Resilience Facility (RRF) aims at financing projects that directly tackle the economic and social impacts from the Coronavirus crisis and support the green and digital transition. For project ideas that directly contribute to these objectives and that have a strong focus in one member state it is advisable to check access to the RRF for a fast and targeted support.

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.

- Open 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.

In this Work Programme, a pilot is applied to a number of topics for co-programmed partnerships, involving a lower funding rate of 60% (except for non-profit legal entities), in order to enhance industrial contributions. It applies to topics starting above TRL 4 and reaching TRLs 7 and 8.

DESTINATION – 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 open 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 open 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 ecosystem (driven mainly by SMEs) offers 22 million jobs and contributes 10.5% of EU-27 global value added [2]. 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.[3] 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 industries are important to its economy, its resilience and its environmental credentials. Process industries are responsible for a turnover of > 2 trillion, 8.5 million direct jobs and 20 million indirect jobs. They represent 0.5 million enterprises and 5 % of the EU27 GDP. The process industry however faces two key challenges: a strong global competition, and an environmental challenge. In particular, energy-intensive industries are resource intensive, using extensive amounts of raw materials (often imported and fossil based). In their operations, they generate large amounts of waste, 20% of global greenhouse gases (GHG) but also pollutants. The industries need 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. By 2030, decisive steps need to be taken given the long investment cycles these industries are facing. As the process industry is transforming primary raw materials into materials ready for use by the manufacturing industry, it will play a key role in the pathways toward circularity of materials by transforming industrial and end-of-life waste into secondary raw materials leading to the same quality output in the newly produced materials.

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

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[2] 'Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery', COM(2021)350 final and associated Staff Working Documents

[3] The digital intensity of the construction sector is below 10%, meaning that the sector has a very slow absorption rate of digital technologies, according to the Digital Transformation Scoreboard 2018, https://ec.europa.eu/information_society/newsroom/image/document/2018-20/4_desi_report_integration_of_digital_technology_B61BEB6B-F21D-9DD7-72F1FAA836E36515_52243.pdf

- 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 CO_2 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 as many as possible new large hubs for circularity by 2025 (TRL 7 or above); developing sustainable ways for circular utilisation of waste streams and CO_2/CO streams; and electrifying industry to enable and foster a switch to a renewable energy system;
- Contribute to a substantial reduction of waste and CO_2 emissions, turning them into alternative feedstocks to replace fossil-based raw materials and decrease reliance on imports.

In order to achieve the expected outcomes, for particular topics international cooperation is clearly not mandatory but advised with some regions or countries to get internationally connected and add additional specific expertise and value to the activities.

In line with the European Green Deal objectives, research and innovation activities should comply with the 'do no significant harm' principle[4]. Compliance needs to be assessed both for activities carried out during the course of the project as well as the expected life cycle impact of the innovation at a commercialisation stage (where relevant). The robustness of the compliance must be customised to the envisaged TRL of the project. In this regard, the potential harm of Innovation Actions contributing to the European Green Deal will be monitored throughout the project duration.

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

[4] as per Article 17 of Regulation (EU) No 2020/852 on the establishment of a framework to facilitate sustainable investment (EU Taxonomy Regulation)

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.

Much of the research and innovation supported under this Destination may serve as a cradle for the New European Bauhaus: this is about designing sustainable ways of living, situated at the crossroads between art, culture, social inclusion, science and technology. This includes R&I on manufacturing, construction, advanced materials and the circular economy approaches.

Business cases and exploitation strategies for industrialisation: This section applies only to those topics in this Destination, for which proposals should demonstrate the expected impact by including a *business case and exploitation strategy for industrialisation*.

The *business case* should demonstrate the expected impact of the proposal in terms of enhanced market opportunities for the participants and enhanced manufacturing capacities in the EU, in the short to medium term. It should describe the targeted market(s); estimated market size in the EU and globally; user and customer needs; and demonstrate that the solutions will match the market and user needs in a cost-effective manner; and describe the expected market position and competitive advantage.

The *exploitation strategy* should identify obstacles, requirements and necessary actions involved in reaching higher TRLs, for example: matching value chains, enhancing product robustness; securing industrial integrators; and user acceptance.

For TRLs 7-8, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

Activities beyond R&I investments will be needed to realise the expected impacts: these include the further development of skills and competencies (also via the European Institute of Innovation and Technology, in particular EIT Manufacturing); and the use of financial products under the InvestEU Fund for further commercialisation of R&I outcomes.

Where relevant, in the context of skills, it is recommended to develop training material to endow workers with the right skillset in order to support the uptake and deployment of new innovative products, services, and processes developed in the different projects. This material should be tested and be scalable, and can potentially be up-scaled through the European Social Fund Plus (ESF+). This will help the European labour force to close the skill gaps in the relevant sectors and occupational groups and improve employment and social levels across the EU and associated countries.

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 CO_2/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)
	2021	2022	
HORIZON-CL4-2021-TWIN-TRANSITION-01	402.60		23 Sep 2021
HORIZON-CL4-2022-TWIN-TRANSITION-01		321.50	30 Mar 2022
Overall indicative budget	402.60	321.50	

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

Call	Budgets (EUR million)		Deadline(s)
	2021	2022	
HORIZON-CL4-2021-TWIN-TRANSITION-01	403.00		23 Sep 2021
HORIZON-CL4-2022-TWIN-TRANSITION-01		334.50	30 Mar 2022
Overall indicative budget	403.00	334.50	

Call - TWIN GREEN AND DIGITAL TRANSITION 2021

HORIZON-CL4-2021-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)[5]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[6]	Number of projects expected to be funded
Opening: 22 Jun 2021 Deadline(s): 23 Sep 2021				
HORIZON-CL4-2021-TWIN-TRANSITION-01-01	IA	28.00 [7]	8.00 to 10.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-02	IA	27.00	8.00 to 10.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-03	RIA	26.00	5.00 to 7.00	4
HORIZON-CL4-2021-TWIN-TRANSITION-01-05	RIA	20.00	4.00 to 6.00	4
HORIZON-CL4-2021-TWIN-TRANSITION-01-07	IA	18.00 [8]	4.00 to 6.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-08	IA	24.00 [9]	4.00 to 8.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-	IA	15.00	Around	3

5 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.

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

7 Of which EUR 15.94 million from the 'NGEU' Fund Source.

8 Of which EUR 10.19 million from the 'NGEU' Fund Source.

9 Of which EUR 13.52 million from the 'NGEU' Fund Source.

01-10			5.00	
HORIZON-CL4-2021-TWIN-TRANSITION-01-11	RIA	21.00	6.00 to 10.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-12	RIA	24.00	8.00 to 10.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-14	RIA	28.00 [10]	8.00 to 12.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-16	CSA	2.00	Around 2.00	1
HORIZON-CL4-2021-TWIN-TRANSITION-01-17	IA	39.00 [11]	12.00 to 18.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-18	IA	28.00 [12]	6.00 to 8.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-19	IA	14.00	4.00 to 5.00	4
HORIZON-CL4-2021-TWIN-TRANSITION-01-20	IA	36.00 [13]	Around 12.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-21	IA	39.00	12.00 to 18.00	3
HORIZON-CL4-2021-TWIN-TRANSITION-01-22	IA	14.00 [14]	4.00 to 5.00	3
Overall indicative budget		403.00		

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

[10] Of which EUR 15.64 million from the 'NGEU' Fund Source.
[11] Of which EUR 19.27 million from the 'NGEU' Fund Source.
[12] Of which EUR 14.94 million from the 'NGEU' Fund Source.
[13] Of which EUR 19.63 million from the 'NGEU' Fund Source.
[14] Of which EUR 7.47 million from the 'NGEU' Fund Source.

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

Green, flexible and advanced manufacturing

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-TWIN-TRANSITION-01-01: AI enhanced robotics systems for smart manufacturing (AI, Data and Robotics - Made in Europe Partnerships) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 28.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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:

- Provide safe, highly flexible, reconfigurable and modular solutions, allowing fast response to repurposing changes in production requirements, reducing considerably programming effort and configuration time for new products;
- Demonstrate significant improvements towards a meaningful and seamless social collaboration in teams of human workers, autonomous agents and robots by exploiting the latest advancements in AI, robotics and Social Sciences and Humanities (SSH);

- Create a network of open-access pilots to allow new users, especially students, start-ups, representatives from the makers' community and SMEs, to experiment new technologies and to enable data and knowledge sharing through the European industrial ecosystems.

Scope: EU and Associated countries need to strengthen their capacity to manufacture and re-manufacture goods in a sustainable and competitive way to be ready to expand into new value chains. The recent crisis has also shown the importance of resilient, flexible, reconfigurable and responsive data-driven manufacturing lines.

Projects should seize the opportunities arising from the latest state-of the art-developments in AI and robotics to deploy intelligent and autonomous systems for flexible production.

Research activities should be multi-disciplinary and address all of the following areas:

- Development of robust, easy to use, explainable and compliant AI tools for manufacturing environments that require minimal learning and can be configured without highly skilled personnel;

- Implement and integrate the latest research findings on technologies such as sensors, actuators, control, edge computing, haptic technologies, mechatronics, robotics and autonomous systems to enhance collaborative robotics systems in order to develop advanced smart manufacturing human-machine collaborative systems ensuring safe physical and social interactions and efficient collaboration with human workers;

- Demonstrate complex, safe and efficient collaboration between multiple agents simultaneously, e.g. humans, autonomous agents, industrial machinery, AGVs and collaborative robots;

- SSH should provide a variety of human-centric approaches to develop smooth collaboration in the human-machine teams; to improve user experience; and increase awareness comfort, trust, skill and safety (physical and social) of workers in highly automated industrial environments by incorporating a greater understanding of linguistic, historic, and cultural concerns of end-users and workers , while taking into consideration a gender and intersectional perspective;

- Demonstrate results in at least three large-scale industrial use-cases, targeting sectors and tasks typically difficult to automate.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan and/or South Korea in view of the long cooperation with EU on AI, robotics and manufacturing.

This topic implements jointly the co-programmed European Partnerships Made in Europe and AI, Data and Robotics.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 27.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

<u>Expected Outcome</u>: 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 address 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. In addition the project could consider the use of large data sets and analysis, stemming from all sorts of production process and material data, possibly supported by data-sharing between sites, for the creation of comprehensive machine learning algorithms.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

HORIZON-CL4-2021-TWIN-TRANSITION-01-03: Laser-based technologies for green manufacturing (Photonics - Made in Europe Partnerships) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 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, sintering, 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 in the time required by the system to react with a feedback control action.

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 relevant 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 when compared to non-bio-based materials;
- 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 reusable and recyclable products based on bio-based materials should increase substantially in order to build a truly sustainable manufacturing industry.

These technologies provide a valid alternative to conventional 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, injection moulding, extrusion etc., to unlock the full potential of bio-based materials, such as carbon-positive bioplastics, biopolymers and other fibre-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;
- Combine the use of different bio-based materials to facilitate refurbishing and re-manufacturing of products to achieve circularity by design
- Adapt existing or new characterisation methods and quality controls for the bio-based materials in different formats and for new and regenerated 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.
- Address standardization activities of bio-based materials and adapted characterisation methods and quality controls for bio-based materials in their different formats and applications.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements the co-programmed European Partnership 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 (AI, Data and Robotics - Made in Europe Partnerships) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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 trustworthy AI technologies;
- Improving the environmental sustainability of industrial production;
- Improving the agility of European industry and its resiliency to external and internal influences;
- Integrating state-of-the-art AI technologies with advanced circular manufacturing and re-manufacturing technologies and systems, exploiting their potential across the entire product and service lifecycle;

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 to support circular production in 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 context awareness and information sensed from the physical environment, and will have the long useful lifetime typical of industrial environments.

Projects have to address the need for AI tool sets with simplified interfaces requiring only easy to acquire skills, and adapted to manufacturing environments without highly skilled personnel. Methods and tools will be provided to make AI solutions usable also for lower volume production and shorter time series, guaranteeing the quality of results even while

using reduced resources for the training of AI algorithms. Generative approaches could be considered to help designing products and processes improving the sustainability of industrial solutions. The topic will integrate new or existing technologies to make them practically and economically viable in the industrial world; this should be demonstrated through at least two realistic use cases with demonstrable economic return.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

This topic implements jointly the co-programmed European Partnerships Made in Europe and AI, Data and Robotics.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 24.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio 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.

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 and notably at the edge of the network, 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 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[15], 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.

Proposals are expected to address one of the following technology areas for data-driven industrial environments:

- 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.

[15] In this context, “deep industrial data” means data available only internally in an industrial process (e.g., data used in a manufacturing machine or a logistic process), and not normally shared across the value chain.

- 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 there 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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, in line with the aims of the New European Bauhaus initiative.[16]

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;

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

- Demonstrate new tools and solutions for the storing, processing, analysis and retrieval of administrative and regulatory information related to construction works; and facilitate stakeholders to consult the current status of the process at all times. 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) with support for enabling Augmented Reality/Virtual reality and additional novel features, 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 Directive[17];

- 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, standards, 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, inclusivity including gender issues, 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 project[18];

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17 See https://inspire.ec.europa.eu/about-inspire/563
18 See https://cordis.europa.eu/project/id/856943

- 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Finally, proposals should provide contributions to relevant standards and seek to ensure synergies with the Horizon Europe 'Built4People' co-programmed Partnership. 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 significantly the construction and demolition waste (CDW) utilisation (at least 80% weight in line with the current waste Directive 2008/98/EC[19] as amended by Directive 2018/851[20]) by cascade approach including re-use, recycle 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.

[19] Directive 2008/98/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098
[20] Directive 2018/851: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018L0851

- Increase by 50% the reusability 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, steel and aluminium (or other metals), the embodied energy and embodied eq. CO_2 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 construction or demolition sites. The proposed tools should use as far as possible existing databases for waste management;

- 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 (reutilisation, recycling, transformation, etc.) in at least four implementation sites across different European countries, considering the material recovery, transformation and utilisation;

- Assess the value of the solutions in terms of the additional monetary value/reduction of eq. CO_2 emissions produced;
- Besides the new solutions benefits, safety should be considered (on construction issues, hazardous materials, etc.)
- 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 or best practices.
- The projects should provide contributions to relevant standards or best practices.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

HORIZON-CL4-2021-TWIN-TRANSITION-01-12: Breakthrough technologies supporting technological sovereignty in construction (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 24.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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:

- Integrate breakthrough technologies derived from other industries: examples include additive manufacturing; human robot collaboration; autonomous vehicles in construction activities; autonomous maintenance, diagnostics and monitoring;
- Demonstrate the impact of the use of these new breakthrough technologies on the efficiency of resources (raw materials, water etc.), the reduction of waste and embodied CO_2 emissions;
- Demonstrate the safety of these breakthrough technologies on a construction environment in cooperation with workers;

- Demonstrate a reduction of dependency for importing breakthrough technologies related to additive manufacturing, human robot collaboration or autonomous vehicles;
- Increase the wellbeing of the construction workforce concerned.

Scope: There is a global trend for higher digitalisation in the construction sector. In this context, there is a major need to ensure that construction activities in countries in Europe do not depend on breakthrough technologies the industry concerned needs to import from outside Europe to remain competitive. Currently, the construction sector is among the least automated and digitised and the most labour accident-prone sectors in the Europe. Therefore, the use of technologies such as additive manufacturing, autonomous vehicles and human robot collaboration in a construction environment is crucial to increase the degree of digitalisation of the sector. In addition, Member States are facing a shortage of skilled labour force in construction activities. In the same vein, a higher degree of digitalisation would make the construction sector attractive for younger generations and construction sites a safer working environment. Proposal consortiums are encouraged to include a wide range of stakeholders from SMEs to large construction firms.

The projects should:

- Develop, test and promote the necessary technologies, devices and systems for an highly automated construction site;
- Demonstrate all developed solutions in at least four diverse construction sites (such as roadwork, bridges, tunnels, different types of buildings, etc.) across different countries in Europe;
- 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;
- 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;
- Identify additional breakthrough technologies bearing an emerging serious risk of import dependency;
- Contribute to the development of new relevant standards or update of existing ones.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

In order to achieve the expected outcomes, international cooperation is encouraged, in particular with Japan or South Korea in view of the cooperation on digital technologies.

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 solutions for the utilization of energy, water, industrial waste and by-products at regional scale (Processes4Planet Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 28.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to 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 exemplary pilot solutions of the Industrial-Urban Symbiosis (I-US) concept, making the flows of energy, waste and water circular; and 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;
- Plan a list of actions to overcome non-technological barriers for exploitation of cross-company symbiosis (i.e. waste regulations, standardisation, confidentiality and compliance, ownership, fair sharing of benefits, acceptance of the concept);
- Set up facilitation services for helping implementation of symbiotic processes directed to local authorities, and relevant businesses, private/industry actors, especially SMEs;

- Develop best practices for 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;

- Explore and virtually demonstrate replication potential in other regions (i.e. by setting up a network amongst waste associations to optimise flow of secondary raw materials);

- Implement actions to facilitate relations and to involve the local community actors (authorities, associations, civil society, relevant businesses, especially SMEs, educational organisations, etc.), e.g. exchanging knowledge and human capital with the educational establishments and developing flexible learning resources.

- Implement a social innovation spin-off action[21] involving one of the local community actors.

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, industrial side streams, 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 connexion with local energy and utility networks, adjacent industrial infrastructures and available by-products is crucial and will have to be considered in a holistic approach.

Technology and social 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 several but not necessarily all following aspects:

- 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;

[21] A social innovation spin-off action may not necessarily encompass a commercial activity.

- 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 (including AI driven tools for the discovery of hidden pathways), 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/use (preferred) of common reporting methodologies for the assessment of industrial symbiosis activities and exchanges in close collaboration with the European Community of Practice (ECoP);
- 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. Interoperability for data sharing should be addressed.

Clustering and cooperation with other selected projects under this cross-cutting call and others in HE, with European initiatives (as for example: Circular Cities and Regions Initiative (CCRI) and European Circular Economy Stakeholder Panel (ECESP)), as well as building on

existing projects[22] is strongly encouraged, see also Industrial Symbiosis Report from March 2020[23].

In order to achieve the expected outcomes, international cooperation is encouraged on IS/I-US/circularity technologies and their implementation in processes, with INCO countries advanced in the field that could bring mutual benefit from different perspective.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2021-TWIN-TRANSITION-01-16: Hubs for Circularity European Community of Practice (ECoP) platform (Processes4Planet Partnership) (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project is 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;
- Provide up-to-date support to the H4C by collecting and evaluating knowledge, tools, models and solutions and making them accessible to the community, preparing training material dedicated to circular practitioners that can drive the H4C roll out across Europe;
- Define a set of methodologies and kits of specific KPIs (e.g. a kit for any single industrial sector) to enable the progress quantification of circularity and symbiosis with particular attention to the definition of gaps to be closed in order to reach the expected impact.

[22] e.g. Sharebox, Scaler, CIRCLEAN network or JRC Industry mapping EIGL, etc.
[23] Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1

- 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-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 (Symbiosis Readiness Level, SRL) [24] 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 pilots of advanced H4C by 2026, supported by a solid blended funding strategy, targeting the accomplishment of 2050 Green Deal Goals;
- 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 public and private investments in circular economy projects;
- Set up an effective collaboration with stakeholders represented in the P4Planet partnership, including non-governmental associations, and provide a solid plan for the continuation and self-financing of ECoP after the completion of the project;
- Drive and coordinate business-to-territory relationships in the area in which the H4C, or neighbouring H4C, are located (i.e. with authorities, SMEs, associations, educational organisations, civil society, etc.).

Scope: 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 reductions, within a given representative geographical area. H4C 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 ECoP is a tool for connecting the Hubs and the community of interest into a network for exchanging tools and knowledge across regions. It has also been proposed by Processes4Planet partnership. The project will embrace possibly all existing H4C and circular systemic activities and strongly link with the activities of relevant European Partnerships, such as P4Planet.

[24] Industrial symbiosis report published in March 2020

The ECoP should:

- Gather, evaluate and synthesise state-of-the-art knowledge on circularity and industrial symbiosis and work out their benefits for climate neutrality and competitiveness in relation to their possible applications. This work should embrace the outcomes of all previously funded projects and be subject to constant updates;
- Characterise, classify and evaluate systematically symbiosis and circularity-related solutions with a constant update of 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 H4C implementation. The regions/areas to consider should involve all alternative resource streams relevant for process industries as potential source of feedstock or as utilities, I-US scenarios and infrastructures that are already in place; scrutinise co-investment scenarios (combination of public and private means) to reach high Symbiosis Readiness Levels (SRL).
- Analyse proven involvement of regions and local communities;
- Identify high-potential regions/areas, for developing the first demonstrator of H4C by 2026. Such identification should be justified on the basis of objective criteria and should be open to further regions in the course of the project. Criteria should focus on process level, symbiosis process implementation, commitment level of the local authorities and communities, regional specificities (business/industrial policy and strategies), additional funding, potential private investors, etc. These hubs should become lighthouse examples of win-win cooperation between industry, SMEs, public authorities, educational institutions and civil society on circular economy beyond 2026;
- 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;
- 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 and service 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 Process4Planet, Made in Europe and Clean Steel but also under cluster 6 dealing with circularity will be required to provide complete information and full collaboration to the ECoP platform.

Clustering and cooperation with other selected projects under this cross-cutting call and others in HE, and with European initiatives (as for example Circular Cities and Regions Initiative (CCRI) and European Circular Economy Stakeholder Panel (ECESP)), building on existing H2020 projects[25] is strongly encouraged, see also Industrial Symbiosis Report from March 2020.[26].

This topic implements the co-programmed European partnership Processes4Planet.

Enabling circularity of resources in the process industries, including waste 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 (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 12.00 and 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[25] e.g. Sharebox, Scaler, CIRCLEAN network or JRC Industry mapping EIGL, etc.
[26] Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1

Indicative budget	The total indicative budget for the topic is EUR 39.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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 Renewable Energy Sources (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 fossil 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 can be single or multi-step (e.g. pre-treatment, grinding, etc.) and 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 co-design of learning resources together with local and regional educational organisations for current and future generations of employees, with the possibility of integrating them in existing curricula and modules for undergraduate level and lifelong learning programmes. Learning resources should integrate the identification of new skills and should propose innovative learning-teaching methods that meet regional social needs and have a high potential for replication.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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: Electricity and hydrogen-based metallurgy (Clean Steel Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 28.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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 sector leading to a reduction of CO_2 emissions by 2050 by at least 80 to 95% compared to 1990 levels;
- Improve energy and resource efficiency and increase utilisation of renewable energy sources[27] in metallurgical processes to substitute fossil fuels;
- Enabling steel production through carbon direct avoidance (CDA) technologies at a demonstration scale;
- Efficient integration of renewable energy sources, considering also their intermittency and the possibility to offer demand-response flexibility.

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 CO_2 emission reduction in the steel sector.

[27] 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 CO_2 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 CO_2 reductions of up to 95% by 2050 compared to 1990 levels.

There is no one solution to achieve low-CO_2 steelmaking, as there is expected to be a variety of production technologies in the future. Relevant participation from sectors other than steel is not excluded, if the technologies presented are compatible with the expected outcomes of the topic and the Clean Steel partnership objectives.

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 CO_2 neutral steelmaking;
- Improvement of plasma melting processes with improved electrode technologies using a plasma torch or plasma smelting reduction leading to CO_2 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 focused 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;

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

Specific conditions

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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;
- Reducing the environmental impact by minimizing CO_2 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:
    - the reduction of pig iron use the in the steelmaking process;
    - the use of alternative reducing agents as coal substitution, such as biomass, polymers, hydrogen;

- the reduction of CO_2 emission derived by extraction and transportation of natural resources as well as transportation and landfill of industrial waste;
- the generation of CO_2 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 CO_2 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 H_2-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 CO_2 sequestration, heat accumulator);
- Integration of energy recovery solutions in metal recovery processes targeting at a better Return of Investment.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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 topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.

Technology Readiness Level	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 increase circularity of extractive and processing value chains; and, where relevant, reduce contaminants and impurities in extracted raw materials;
- Develop methods, technologies and processes for mining and processing aiming at significantly decreased emissions (CO_2 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[28]:

- 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.

[28] COM (2020) 474

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).

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

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 and in non-EU countries of project's partners 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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 (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 12.00 and 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 39.00 million.
Type of Action	Innovation Actions
Technology	Activities are expected to start at TRL 5 and achieve TRL 7 by the

Readiness Level	end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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, including possible onsite energy storage and conversion;
- Overall increased energy efficiency of the industrial process within the energy system;
- New digital tools that account for the energy availability to realise the additional flexibility of the process and that create connections to energy grid platforms 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 a renewable energy share to deliver the EU Green Deal objectives and which goes significantly beyond the current target of 32%. 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 support the change of energy supply, current processes, designed to run continuously at maximum capacity, have to be adapted. Besides, energy efficiency measures will help decreasing the overall process energy demand. To leverage the flexibility in process industries, digital process control systems that optimise the process while accounting for the value of flexibility need to be implemented.

Digital tools need to be developed to attain the energy flexibility of the process, but also to exchange data with network operators and flexibility markets (through market operators, suppliers and/or aggregators), which will enable industries to provide flexibility services. Powerful digital twins based on suitable combinations of analytical models, physics-based AI or pure AI solutions need to be designed and applied. To find optimal control solutions in a minimal time, digital twins could be empowered, for example, by multi-agent systems technologies.

Moreover, the direct integration of renewable energy generation and the higher overall efficiencies will require further flexibility solutions in process industries. Onsite energy storage or conversion in the form of electricity, heat or other energy vectors can further increase an installation's flexibility.

Proposals should address the following aspects:

- In an existing process, identification of potential flexibility that 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) or the shift from batch processes to continuous processes, etc., including the removal or adaptation 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 a higher energy efficiency at subsystem level;
- Development or redesign of digital process control systems, including, e.g., digital twins with integrated multi-agent systems, etc., supported by smart sensors and integrated analytical tools, to realise the flexibility of the process and to create connections to grid integration platforms;
- Evaluation of the potential use of onsite energy storage and conversion (electricity, heat, or other energy vectors) for the proposed flexible solution and integration of such energy solutions whenever relevant and feasible;
- Optimisation of the new process design at pilot scale.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. Additionally, proposals should include a safety assessment and a life cycle assessment for the implementation of the developed technologies; and a contribution to standardisation, wherever possible.

Proposals should include activities that specifically target the collaboration with other European projects on energy flexibility in their work plan (for example, a dedicated work package or task).

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

This topic implements the co-programmed European partnership Processes4Planet.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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 hydrogen 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 (H_2), e.g. by replacement of fossil carbon as reducing agent with hydrogen and biomass.

This also includes the integrated preparation (reforming, separation, heating, compression) of external carbon-lean reducing gases or internally-recycled CO/CO_2 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 metallurgical gases 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 CO_2 capture and storage technologies for the transition to CO_2 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 - CLIMATE NEUTRAL, CIRCULAR AND DIGITISED PRODUCTION 2022

HORIZON-CL4-2022-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)[29]

Topics	Type of	Budgets (EUR	Expected EU	Number of

[29] 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.

	Action	million)	contribution per project (EUR million)[30]	projects expected to be funded
		2022		
Opening: 12 Oct 2021 Deadline(s): 30 Mar 2022				
HORIZON-CL4-2022-TWIN-TRANSITION-01-01	IA	27.50 [31]	8.00 to 10.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-02	RIA	21.50	4.00 to 6.00	4
HORIZON-CL4-2022-TWIN-TRANSITION-01-03	RIA	21.50 [32]	4.00 to 6.00	4
HORIZON-CL4-2022-TWIN-TRANSITION-01-04	RIA	21.50	4.00 to 6.00	4
HORIZON-CL4-2022-TWIN-TRANSITION-01-06	IA	30.00 [33]	4.00 to 8.00	4
HORIZON-CL4-2022-TWIN-TRANSITION-01-07	RIA	22.00 [34]	3.00 to 6.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-09	IA	9.00	Around 4.50	2
HORIZON-CL4-2022-TWIN-TRANSITION-01-10	IA	42.50	12.00 to 18.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-11	IA	42.50 [35]	12.00 to 18.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-13	IA	14.00 [36]	4.00 to 5.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-15	RIA	30.00	8.00 to 12.00	3

30 Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
31 Of which EUR 12.85 million from the 'NGEU' Fund Source.
32 Of which EUR 11.30 million from the 'NGEU' Fund Source.
33 Of which EUR 25.95 million from the 'NGEU' Fund Source.
34 Of which EUR 13.03 million from the 'NGEU' Fund Source.
35 Of which EUR 34.60 million from the 'NGEU' Fund Source.
36 Of which EUR 12.11 million from the 'NGEU' Fund Source.

HORIZON-CL4-2022-TWIN-TRANSITION-01-16	IA	10.00	Around 3.00	3
HORIZON-CL4-2022-TWIN-TRANSITION-01-17	IA	42.50 [37]	12.00 to 18.00	3
Overall indicative budget		334.50		

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

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 (Made in Europe Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[37] Of which EUR 36.33 million from the 'NGEU' Fund Source.

Indicative budget	The total indicative budget for the topic is EUR 27.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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 of more flexible systems, 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. Projects should provide strategies for awareness and early detection of reconfiguration needs, e.g. by using A.I. and data technologies, to enhance their resilience towards threatening events or crisis situations.

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 with minimal reconfiguration costs.

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

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

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 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, inkjet etc.), plating/implantation (electroplating, vacuum plating/coating, etc.), thermal treatments (annealing, thermo-chemical processes, etc.), laser-based treatments (annealing, texturing, etc.), additive manufacturing, micro manufacturing (micro electrical discharge machining, micro milling, etc.) chemical and electrochemical treatments (anodizing, electropolishing, chemical deposition, etc.), biochemical treatments, 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 and flexible 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

HORIZON-CL4-2022-TWIN-TRANSITION-01-03: Excellence in distributed control and modular manufacturing (Made in Europe Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 and throughout the supply chain;
- Improved understanding among industrial 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 to 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 and workers' 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 these 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 training and knowledge transfer to relevant parts of the workforce.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

HORIZON-CL4-2022-TWIN-TRANSITION-01-04: Intelligent work piece handling in a full production line (Made in Europe Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to 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 program advanced control systems capable of intelligent handling 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 a strong need for efficient, flexible, reconfigurable and data-driven 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 high variety of work pieces which might be available as 3D models or just as physical artefacts. Therefore, there is an increasing demand for innovative smart automated handling systems.

Multidisciplinary research activities should include SSH and 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, lightweight, flexible and versatile grippers, IoT, integrated physical and biochemical sensors (e.g. mechanical, magnetic, optical, electrochemical), image processing, simulation, modelling, data acquisition, data storage/sharing, data interoperability, data analytics, automated planning 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 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 targeting different manufacturing processes and sectors, e.g. food & beverage preparation and packaging, metalworking, product assembly, textile processing and production, etc.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

This topic implements the co-programmed European Partnership 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) (Made in Europe Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio 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.

Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The maximum amount to be granted to each third party is EUR 60 000. The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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

- Making European manufacturing companies, especially SMEs and small 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 centres 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 submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 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 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, refurbishing, 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 across different industry sectors; 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 along their lifecycle. Where appropriate, proposals need to be able to link up with manufacturing industrial data spaces platforms, 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed. Additionally, a strategy for skills development should be presented, associating social partners when relevant.

All projects should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

A new way to build, accelerating disruptive change in construction

Proposals are invited against the following topic(s):

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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, taking into account issues of accessibility as well as inclusivity;
- 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 for instance by structural health monitoring; cost effectiveness, efficiency gains in terms of time; enhanced climate resilience.

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, thereby facilitating better design choices and greater sustainability, contributing in this way to the New European Bauhaus initiative.

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, climate resilience;
- 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; introduce a Common Information Model for next generation DBL capitalizing on existing standards and proposing extensions for missing features;
- 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 should take into account issues of accessibility and inclusivity, such as age, gender, disability, and socio-economic background.

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

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Finally, proposals should provide contributions to relevant standards and seek to ensure synergies with the Horizon Europe ‘Built4People’ co-programmed Partnership.

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

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-TWIN-TRANSITION-01-10: Circular flows for solid waste in urban environment (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 12.00 and 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 42.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial	The rules are described in General Annex G. The following

set-up of the Grant Agreements	exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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, valorising 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, advantages, 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;
- 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 actions to facilitate relations and to involve the local community actors (authorities, associations, civil society, relevant businesses, especially SMEs, educational organisations, etc.), e.g. exchanging knowledge, training, human capital, contributing to the optimisation of job profiles and sharing with the local educational establishments and with the ECoP;
- Implement a social innovation spin-off action[38] involving one of the local community actors.

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 waste are intended here as process industry, manufacturing industry, construction industry waste and solid urban waste (consumer waste, End-of-Life waste). Solid waste in general is one of the biggest waste streams in Europe, accounting for more than 30% of all waste

[38] A social innovation spin-off action may not necessarily encompass a commercial activity.

generated in the EU (Dec.2019 data)[39], 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. 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, refining, concentration, processing (e.g. thermal, mechanical), recycling technologies (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 build a new circular value chain including energy, water and material flow, infrastructure and logistics;
- Investigate the availability and distribution of “waste” resources and logistic to ensure proper input of the specified material of the right quality and quantity to feed the new process in time;
- 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;
- Define assessment methodologies and evaluate KPIs to measure the performance of symbiosis (SRL) and 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;
- 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.

[39] https://ec.europa.eu/environment/waste/index.htm

- Connect to the ECoP for knowledge sharing: know-how, challenges and recommendations on technological and non-technological aspects;

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. Interoperability for data sharing should be addressed.

Clustering and cooperation with other selected projects under this call and others in Horizon Europe, with European initiatives (as for example: Circular Cities and Regions Initiative (CCRI) and European Circular Economy Stakeholder Panel (ECESP)), as well as building on existing projects,[40] are strongly encouraged; see also Industrial Symbiosis Report of March 2020[41].

This topic implements the co-programmed European partnership Processes4Planet.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

Enabling circularity of resources in the process industries, including waste 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 (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 12.00 and 18.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 42.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of

[40] e.g. Sharebox, Scaler, CIRCLEAN network, JRC EIGL, etc.
[41] Study and Portfolio Review of Cluster of Projects on Industrial Symbiosis https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1

	the total eligible costs.

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

- Utilise CO/CO_2 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/CO_2 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/CO_2 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/CO_2 streams from point sources (e.g. large industrial installations 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/CO_2 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 co-design of learning resources together with local and regional educational organisations for current and future generations of employees, with the possibility of integrating them in existing curricula and modules for undergraduate level and lifelong learning programmes. Learning resources should integrate the identification of new skills and should propose innovative learning-teaching methods that meet regional social needs and have a high potential for replication.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This topic implements the co-programmed European partnership Processes4Planet.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 6 and achieve TRL 8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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 CO_2 emissions;
- Technologies allowing upgrade processes in low grade iron ores to make them suitable for pelletisation 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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 (Processes4Planet Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 by shifting from the chemical conversion process to an electrochemical conversion process;
- Efficient integration of renewable electricity to drive the conversion process;
- Significant reduction of CO_2 emissions of the overall industrial process, including the emissions related to the generation of the electricity;
- 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 CO_2 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 such as hydrogenation of biomass into valuable chemicals, recovery of metals from waste streams (including strategic or scarce materials), electrosynthesis of ammonia and organic molecules, production of lime by electrochemical splitting, electrolytic production of metals, (in-situ) production of hydrogen peroxide or ozone, etc.

Advanced electrochemical systems, configurations and novel technologies can enable higher efficiencies and/or lower investments or operational costs. 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. Paired synthesis, where two valuable products are generated through the cathodic and anodic reactions, can help to reduce energy consumption and 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 and optimisation with the development of advanced materials and reactor/cell components as well as low-energy separation processes.

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, reactor/cell and separation methods, 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 CO_2 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 business case and exploitation strategy, as outlined in the introduction to this Destination.

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 encouraged, in particular with Japan.

This topic implements the co-programmed European partnership Processes4Planet.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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;

- Integration of fuel cells, electrolysers or alternative carbon-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. .

- 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 CO_2 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 CO_2 and H_2O, e.g. through scrubbing or reforming operations. To make a real difference on CO_2 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

HORIZON-CL4-2022-TWIN-TRANSITION-01-17: Integration of hydrogen for replacing fossil fuels in industrial applications (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of between EUR 12.00 and 18.00 million would allow these outcomes to be addressed

project	appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 42.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs. This funding rate applies both to members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

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

- Significant reduction of CO_2 emissions of the industrial process, whilst keeping NOx levels at least not higher than the equivalent gas-based solutions
- 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, heaters or boilers. 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 design of the new burners must include aspects that minimise the NOx formation, associated to conventional hydrogen burners, such as lower flame temperature, slower combustion, etc.

The future large demand of green hydrogen will lead to large-scale oxygen production in the water electrolysis. Although oxygen can be harmlessly vented, the by-product oxygen can be captured and effectively used in industrial processes. Using oxygen instead of air in combustion reactions can reduce the energy use of the combustion, increase heating system efficiency and reduce the energy loss in the exhaust gases.

The proposals should address 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, plus possible measures to minimise NOx emissions;
- Modification of the heating equipment and infrastructure required for the use of hydrogen, e.g., new burners and hydrogen compatible equipment materials;
- Development of an oxygen or oxygen-enriched air combustion process that replaces an air combustion process, considering the energy and cost efficiency of the process;
- 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, in comparison with other heating alternatives.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Proposals submitted under this topic should include a safety assessment, in line with the Safety Planning for Hydrogen and Fuel Cell Projects of the European Hydrogen Safety Panel, 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, as well as dissemination notably within the communities of the Process4Planet partnership and of the Clean Hydrogen Joint Undertaking.

This topic implements the co-programmed European partnership Processes4Planet.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

DESTINATION – 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 coin[42]. 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.

[42] 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 tackle missing segments in strategic areas and value chains, to strengthen the EU's industrial base and boost its competitiveness and open strategic autonomy. In addition, it will explore how increased circularity has the potential to increase the open 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, dual-use and digital applications). In a context where demand is set to increase[43], these will remain, more than ever, a vital prerequisite for both Europe's open strategic autonomy and a successful transition to a climate-neutral and circular economy. Responding to the Critical Raw Materials action plan R&I activities will 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 Europe[44]. 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.

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43 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.

44 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)

- *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 especially digital, technologies.[45]

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 open 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.

In line with the European Green Deal objectives, research and innovation activities should comply with the 'do no significant harm' principle[46]. Compliance needs to be assessed both for activities carried out during the course of the project as well as the expected life cycle impact of the innovation at a commercialisation stage (where relevant). The robustness of the compliance must be customised to the envisaged TRL of the project. In this regard, the potential harm of Innovation Actions contributing to the European Green Deal will be monitored throughout the project duration.

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.

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45 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

46 as per Article 17 of Regulation (EU) No 2020/852 on the establishment of a framework to facilitate sustainable investment (EU Taxonomy Regulation)

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

Much of the research and innovation supported under this Destination may serve as a cradle for the New European Bauhaus: this is about designing sustainable ways of living, situated at the crossroads between art, culture, social inclusion, science and technology. This includes R&I on manufacturing, construction, advanced materials and the circular economy approaches.

Business cases and exploitation strategies for industrialisation: This section applies only to those topics in this Destination, for which proposals should demonstrate the expected impact by including a *business case and exploitation strategy for industrialisation*.

The *business case* should demonstrate the expected impact of the proposal in terms of enhanced market opportunities for the participants and enhanced manufacturing capacities in the EU, in the short to medium term. It should describe the targeted market(s); estimated market size in the EU and globally; user and customer needs; and demonstrate that the solutions will match the market and user needs in a cost-effective manner; and describe the expected market position and competitive advantage.

The *exploitation strategy* should identify obstacles, requirements and necessary actions involved in reaching higher TRLs, for example: matching value chains, enhancing product robustness; securing industrial integrators; and user acceptance.

For TRLs 7-8, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

Activities beyond R&I investments will be needed to realise the expected impacts: these include the further development of skills and competencies (also via the European Institute of Innovation and Technology, in particular EIT Manufacturing); and the use of financial products under the InvestEU Fund for further commercialisation of R&I outcomes.

Where relevant, in the context of skills, it is recommended to develop training material to endow workers with the right skillset in order to support the uptake and deployment of new innovative products, services, and processes developed in the different projects. This material should be tested and be scalable, and can potentially be up-scaled through the European Social Fund Plus (ESF+). This will help the European labour force to close the skill gaps in

the relevant sectors and occupational groups and improve employment and social levels across the EU and associated countries.

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

Call	Budgets (EUR million)		Deadline(s)
	2021	2022	
HORIZON-CL4-2021-RESILIENCE-01	355.20		23 Sep 2021
HORIZON-CL4-2021-RESILIENCE-02	10.00		25 Jan 2022
HORIZON-CL4-2022-RESILIENCE-01		402.20	30 Mar 2022
HORIZON-CL4-2022-RESILIENCE-02-PCP		9.00	30 Mar 2022
Overall indicative budget	365.20	411.20	

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

HORIZON-CL4-2021-RESILIENCE-01

Conditions for the Call

Indicative budget(s)[47]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[48]	Number of projects expected to be funded
Opening: 22 Jun 2021 Deadline(s): 23 Sep 2021				
HORIZON-CL4-2021-RESILIENCE-01-01	RIA	24.70	8.00 to 9.00	3
HORIZON-CL4-2021-RESILIENCE-01-03	RIA	13.50	Around 13.50	1
HORIZON-CL4-2021-RESILIENCE-01-04	IA	36.00 [49]	Around 12.00	3
HORIZON-CL4-2021-RESILIENCE-01-05	CSA	8.00	Around 8.00	1
HORIZON-CL4-2021-RESILIENCE-01-06	RIA	30.00	Around 7.50	4
HORIZON-CL4-2021-RESILIENCE-01-07	IA	36.00 [50]	Around 12.00	3
HORIZON-CL4-2021-RESILIENCE-01-08	CSA	4.00 [51]	3.00 to 4.00	1
HORIZON-CL4-2021-RESILIENCE-01-09	IA	28.00 [52]	7.00 to 10.00	3
HORIZON-CL4-2021-RESILIENCE-01-10	RIA	23.00 [53]	5.00 to 7.00	3

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.

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

49 Of which EUR 21.78 million from the 'NGEU' Fund Source.

50 Of which EUR 21.78 million from the 'NGEU' Fund Source.

51 Of which EUR 2.42 million from the 'NGEU' Fund Source.

52 Of which EUR 16.94 million from the 'NGEU' Fund Source.

53 Of which EUR 13.91 million from the 'NGEU' Fund Source.

HORIZON-CL4-2021-RESILIENCE-01-11	RIA	19.00 [54]	4.00 to 5.00	5
HORIZON-CL4-2021-RESILIENCE-01-12	RIA	19.00 [55]	4.00 to 5.00	4
HORIZON-CL4-2021-RESILIENCE-01-14	IA	33.00 [56]	7.00 to 10.00	8
HORIZON-CL4-2021-RESILIENCE-01-16	CSA	4.00 [57]	3.00 to 4.00	1
HORIZON-CL4-2021-RESILIENCE-01-17	RIA	21.00 [58]	4.00 to 6.00	4
HORIZON-CL4-2021-RESILIENCE-01-20	RIA	23.00 [59]	4.00 to 6.00	4
HORIZON-CL4-2021-RESILIENCE-01-25	CSA	6.00	2.00 to 4.00	2
HORIZON-CL4-2021-RESILIENCE-01-26	RIA	6.00 [60]	2.00 to 4.00	2
HORIZON-CL4-2021-RESILIENCE-01-27	CSA	4.00	2.50 to 4.00	1
HORIZON-CL4-2021-RESILIENCE-01-28	CSA	2.00 [61]	Around 1.00	1
HORIZON-CL4-2021-RESILIENCE-01-29	CSA	10.00 [62]	Around 5.00	2
HORIZON-CL4-2021-RESILIENCE-01-31	RIA	5.00 [63]	3.00 to 5.00	1
Overall indicative budget		355.20		

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

54 Of which EUR 10.99 million from the 'NGEU' Fund Source.
55 Of which EUR 10.99 million from the 'NGEU' Fund Source.
56 Of which EUR 18.46 million from the 'NGEU' Fund Source.
57 Of which EUR 1.92 million from the 'NGEU' Fund Source.
58 Of which EUR 11.20 million from the 'NGEU' Fund Source.
59 Of which EUR 12.41 million from the 'NGEU' Fund Source.
60 Of which EUR 3.63 million from the 'NGEU' Fund Source.
61 Of which EUR 0.60 million from the 'NGEU' Fund Source.
62 Of which EUR 5.55 million from the 'NGEU' Fund Source.
63 Of which EUR 3.02 million from the 'NGEU' Fund Source.

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

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 (Processes4Planet Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 24.70 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 3 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:

- 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;
- consider the co-design of learning resources together with local and regional educational organisations for current and future generations of employees, with the possibility of integrating them in existing curricula and modules for undergraduate level and lifelong learning programmes; learning resources should integrate the identification of new skills and should propose innovative learning-teaching methods that meet regional social needs and have a high potential for replication.

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This topic implements the co-programmed European partnership Processes4Planet.

Raw materials for EU open 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 13.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). 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 topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.

Technology Readiness Level	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 2018[64];
- 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;

The action is expected to contribute to the implementation of the following actions of the EU action plan on Critical raw materials:[65]

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

Actions 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.

64 https://www.unece.org/energywelcome/areas-of-work/unfc-and-sustainable-resource-management/applications/unfc-and-anthropogenic-resources.html

65 COM (2020) 474

Actions should acquire new data on secondary raw materials via in situ sampling from different regions across the EU, collect existing data and present 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 PROSUM[66] 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 focus on the following streams of secondary raw materials, with particular attention to critical raw materials: waste batteries, WEEE, mining waste, slags and ashes, and construction and demolition waste.

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.

The action 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 and in non-EU countries of project's partners 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Eligibility	The conditions are described in General Annex B. The following

[66] http://www.prosumproject.eu/

conditions	exceptions apply: 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 secondary raw materials, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the expected impacts of the destination by 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 and urban mines, including efficient sorting technologies for separation and recycling.
- 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 or 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.

Actions 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, targeting at least one of the following: waste electrical and electronic equipment (WEEE), batteries, wood-based panels, multi-material paper packaging, end-of-life tyres finishing at Technology Readiness Levels (TRL) 6-7.

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. 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.

Actions should justify importance of targeted raw materials and 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).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

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 also cover social, economic 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately.

project	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: Due to the scope of this topic, legal entities established in all member states of the African Union are exceptionally eligible for Union funding. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely ensuring a diversified, secure, responsible and sustainable supply of raw materials, in particular critical raw materials, to enhance EU open strategic autonomy and strategic security, and to enable the green and digital transitions of EU industrial value chains and strategic sectors, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.

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, mineral 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.

In order to achieve the expected outcomes, international cooperation with partners established in Africa is strongly encouraged.

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

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

The action is expected to contribute to the implementation of the following actions of the EU action plan on Critical raw materials:[67]

- 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.
- Develop strategic international partnerships to secure a diversified supply of sustainable critical raw materials, starting with pilot partnerships with interested countries in Africa in 2021.

Scope: Actions should include:

- 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;

[67] COM (2020) 474

- 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 out an in-depth analysis on financial instruments and investment funds and loans available at member state, EU and international levels for the Africa region.
- Developing in-depth case studies, addressing the above listed actions but not limited to it, for at least six African countries, including DRC, Senegal, Zimbabwe, Mozambique, Gabon and Namibia.

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.

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.

Proposals should take into account issues of accessibility and inclusivity, such as age, gender, disability, and socio-economic background.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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 raw materials,

	and to strengthen EU autonomy as well as socially and environmentally acceptable sourcing, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.

Expected Outcome: Projects 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 (United Nations Framework Classification for Resources) and UNRMS (United Nations Resource Management System) 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 materials[68] 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:

[68] COM (2020) 474

- Generating better geological understanding (i.e. characterization, modelling, mapping) of known mineral deposits to identify critical minerals resources and inform discovery of new resources

- Developing new genetic models for ore deposit types that host critical minerals in order to identify areas for exploration, especially in previously overlooked regions

- Deploying innovative geological, geophysical, geochemical, and data analysis approaches including modelling techniques (e.g. data analysis, remote sensing) to elucidate the geological history and structure and models of targeted spatial areas 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 open 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately.

project	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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 raw materials, to strengthen EU autonomy and to build innovative value chains linking directly raw materials producers and end-users, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Projects 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 and sustainable critical raw materials supply chains for the e-mobility and renewable energy ecosystems and strategic sectors, such as aerospace, ICT and dual-use applications;
- 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) 6-7 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 materials; strategic sectors, such as aero-space and dual-use applications; or on critical raw materials[69], such as rare earths elements for highly performant permanent magnets.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Green and Sustainable Materials

Proposals are invited against the following topic(s):

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[69] Reference to the list of CRMs2020COM (2020) 474 final

Indicative budget	The total indicative budget for the topic is EUR 4.00 million.
Type of Action	Coordination and Support Actions

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-design[70] is a societal urgency[71]. 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:

- 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 e.g. OECD, UNEP, ECHA.
- 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-15, NMBP-16-2020 and other relevant initiatives (e.g. those in WG-E of the EU NanoSafetyCluster) to fill in the gaps in the current understanding;

[70] 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.

[71] Chemicals Strategy for Sustainability COM(2020) 667 final

- 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 with 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-CL4-2022-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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 7.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 28.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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 needs[72].

Projects are expected to contribute to the following outcomes:

[72] Chemicals Strategy for Sustainability COM(2020) 667 final

- 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.

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 units[73] 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.

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;
- Enabling decentralised and continuous processing of high added value chemicals and materials;
- Standardisation of modular production concepts, including international standards.

[73] F3 Factory, Copiride and Synflow projects in FP7

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 23.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.

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 definition of recyclate and develop relevant verification methods for recycled content in products.
- 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 recyclate 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 submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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.

This 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-01-11: Safe- and sustainable-by-design polymeric materials (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 19.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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.

This 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-01-12: Safe- and sustainable-by-design metallic coatings and engineered surfaces (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 19.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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, produced without, and 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 usage of at least 15%;
- Materials modelling, assisted by advanced methods (e.g. physics-based methods, 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

In line with the 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 climate-neutral 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 7.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 33.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4-5 and achieve TRL 6 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 CO_2 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 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 (CO_2 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Where synergies are possible with projects from topics HORIZON-CL4-2021-RESILIENCE-01-16, HORIZON-CL4-2022-TWIN-TRANSITION-01-15, HORIZON-CL5-2021-D3-02-03, and HORIZON-CL5-2022-D3-03-03, cooperation activities are encouraged.

The topic is open for international cooperation, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed[74]

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

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

[74] SWD(2021)97 final, Report on the protection and enforcement of intellectual property rights in third countries (2021)

Type of Action	Coordination and Support Actions

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.

Where synergies are possible with projects from topics HORIZON-CL4-2021-RESILIENCE-01-14, HORIZON-CL4-2022-TWIN-TRANSITION-01-15, HORIZON-CL5-2021-D3-02-03, and HORIZON-CL5-2022-D3-03-03, cooperation activities are encouraged.

The project partners should make provisions to actively participate in the common activities of the large-scale research initiative on Fossil-free fuels and chemicals for a climate-neutral Europe.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 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, airplanes, or stationary storage, 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/lt. 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; the development of suitable pressure vessel designs and materials for the containment of the adsorbent ultra-porous materials should also be addressed.

For long-term storage the proposals are expected to produce a demonstrator plant for low pressure chemical synthesis. Similarly, for the short-term storage solution a demonstrator pressure vessel containing ultra-porous hydrogen adsorbents should be produced.

The proposed solutions should also include full LCA of the new developed materials, (catalysts, ultra-porous materials) and processes (synthesis process, ultra-porous material production).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

The topic is open for international cooperation, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed[75]

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 23.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 health issues;
- 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;

[75] SWD(2021)97 final, Report on the protection and enforcement of intellectual property rights in third countries (2021)

- 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, public transport, hospitals, public buildings, schools, elderly homes etc.) and/or 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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-01-25: Biomaterials database for Health Applications (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Coordination and Support Actions

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. A contribution of SSH expertise in the field of economics and marketing would be beneficial for the achievement of this goal.

Proposals submitted under this topic should include actions designed to facilitate cooperation with other projects, including; relevant ongoing Open Innovation Test Beds[76], 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 6 or more by the end of the project – see General Annex B.

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 where applicable, 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;

[76] Cooperation with projects funded in DT-NMBP-02-2018: OITBs for Safety Testing of Medical Technologies for Health

- Increase competences for data handling among the potential data users (e.g. by providing trainings);
- Ensure high visibility of project results and user-friendly, open access to data and ontologies.

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, for example with EOSC-based initiatives and European Data Spaces.

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

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-01-27: Innovation Radar, Tech Due Diligence and Venture Building for strategic digital technologies (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.50 and 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 4.00 million.
Type of Action	Coordination and Support Actions

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

- A scaling up of capabilities in matching EU-funded technology solutions developed by highly innovative sustainable and digital startups with access to finance and growth opportunities including, but not limited to, other European funding instruments (such as the Digital Europe Programme and EIC), innovation procurement, investors and corporate innovation ventures.

- Deliver, through tech due diligence and venture-building approaches, a step change in the number of new ventures created and ventures' ability to attract funding for sustainable and digital innovations developed in EU-funded R&I.

Scope: The action will use intelligence from the Innovation Radar platform[77] to: facilitate tech due diligence and the building of new ventures based on high-potential innovations and upscaling of HE-funded startups. This will in particular include matching of EU-funded innovations and the innovators behind them with finance and growth opportunities offered by investors, other European funding programmes (including the Digital Europe Programme and EIC), innovation procurement and corporate innovation ventures.

Specific support will be devoted to pilot tech due diligence and venture-building services[78]. The services to be piloted will allow investors to better valuate the technology behind innovations, enable more precise valuations of digital start-ups and prepare their investment readiness. The tech due diligence services will deliver a benefit to spinoffs, startups and scale-ups by improving their access to finance. The pilot will also implement 'venture-building' approaches to dramatically increase the number of new ventures created on the basis of technological breakthroughs that may otherwise be at risk of remaining 'in the lab' despite their market or disruptive potential.

The focus is on strategic digital and industrial technologies.

The cross-cutting action will act as a catalyst to fulfil the potential of startups, in particular those who have secured EU funding (Horizon Europe and Horizon 2020), in delivering market-ready applications and technology solutions that can contribute to the competitiveness and open strategic autonomy of EU industry in key technology areas and value chains. It is foreseen that the communities targeted by the action(s) will contribute to developing applications that foster climate-neutrality, the circular economy, clean industry and user-centric technology development, while also encouraging inclusiveness, and incorporating European social and ethical values.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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77 https://www.innoradar.eu/

78 As foreseen in the European Commission's SME strategy (published 10.03.2020).

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions

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 eco-system;
- 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply:

	The following additional eligibility criteria apply: In order to achieve the expected objectives and/or the specific policy requirements of the topic, the consortium must include at least three entities from at least three Member States or Associated Countries. The following additional eligibility criteria apply: For actions funded under this topic, the same legal entity may only be the coordinator of one action. This means that any legal entity that is the coordinator of the consortium may receive only one grant under this topic. In case the same legal entity is the coordinator in more than one proposal submitted under this topic, only the last submitted proposal will be considered for evaluation.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 50 000.

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 technologies[79], which are underpinning the potential for competitive sustainability of SMEs.

[79] 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 -

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.

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 (in cooperation with EU funded IP support),[80] 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 through calls for SMEs, to implement the elaborated recommendations.

This should support amongst other activities 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

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80 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
https://intellectual-property-helpdesk.ec.europa.eu/index_en; https://intellectual-property-helpdesk.ec.europa.eu/horizon-ip-scan_en; https://euipo.europa.eu/ohimportal/en/online-services/ideas-powered-for-business

business processes, free access and support to use testing facilities, introduction of new IT solutions etc.

The Commission estimates that at least half of the budget should be allocated to financial support to SMEs in the form of third party financing.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

HORIZON-CL4-2021-RESILIENCE-01-31: European Technological and Social Innovation Factory (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions

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

- Strengthened resilience and sustainability – in its economic, social ecological aspects – of the European industries;
- Innovations that combine technological and social innovation and support industry in their transition and the achievement of EU's priorities;
- Inclusive entrepreneurship with a positive social impact;
- A new generation of technologically savvy social entrepreneurs;
- New business models capitalizing on a new partnerships between industry and society;
- New markets.

Scope: Our society is changing. The COVID-19 crisis has shown how quickly society can adapt and bounce back and has underlined how urgent it was for European industry to reinvent itself and increase its resilience. Social innovation holds the potential to support the industry in this transition, especially when linked to technological innovation. Social innovations can contribute to progress and innovation in all areas and change the way all actors in society interact. They appear in new products, services, methods, business models, production processes or new forms of cooperation. They do things differently and involve academia, industry, public authorities, and civil society. Linking the industry with social innovation would thus support the creation of a more resilient, inclusive and democratic

European society and of a dynamic industrial innovation ecosystem while allowing the industry to undertake its transition in a sustainable and fair way.

This topic concerns the generation of innovations that combine technological and social innovation and engage industry and society to serve the EU's priorities. It will provide social innovators with financial and capacity building support to develop their ideas into concrete solutions enabling businesses to transform towards more resilience, sustainability and inclusion. It will also promote a new European culture of social innovation and social entrepreneurship.

Projects should:

- Set up an inclusive mechanism to harvest social innovation ideas. They should issue calls for ideas that are business and industry driven, providing innovative solutions improving the resilience and preparedness of EU businesses in EU policy priority areas and are bottom-up in their approach, involving users and citizens. The following eligibility criterions should be used:

  i. serving at least one EU priority,

  ii. combining technological and social innovation,

  iii. engaging society and industry,

  iv. demonstrated market knowledge and market demand for the solution;

  v. offering an innovative solution.

- Ensure a broad dissemination of the calls to reach out to local social innovators with the support, for instance, of the national competence centres for social innovation funded under the EU Programme for Employment and Social Innovation (EaSI).

- Select approximately 30 of the best entries, using announced eligibility criterions to rank entries. They should award approximately €100000.

- Turn these ideas into pre-market demonstration projects through a process of co-design and co-development, engaging civil society; start-ups, SMEs, mid-caps, and large corporations; academia; public authorities; philanthropists; impact financiers, etc. to the extent appropriate. The consortium should have extensive knowledge in business incubation to be able to provide capacity-building support. Synergies with the ongoing EU funded projects on Incubators for inclusive and social entrepreneurship are encouraged.

- Monitor the testing of the pre-market demonstration projects to demonstrate and document that the social innovation achieves investment grade.

- Help pre-market demonstration projects to find investors through the portfolio of activities (e.g., matchmaking events, dragon-pitches, auctions, etc.) that they consider best suited.

Two thirds of the EU contribution should go to awards to selected entries and to the financing of pre-market demonstration projects.

Applicants are encouraged to envisage additional sources of financing.

Applicants should envisage, as appropriate, clustering activities with other ongoing and future social innovation projects funded under Horizon 2020 or Horizon Europe projects for, inter-alia, cross-project co-operation, consultations and knowledge exchange, joint activities on crosscutting issues as well as participating in joint meetings and communication events. Applicants should plan the necessary budget to cover those activities without the prerequisite to define concrete common actions at this stage.

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

HORIZON-CL4-2021-RESILIENCE-02

Conditions for the Call

Indicative budget(s)[81]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[82]	Number of projects expected to be funded
Opening: 16 Sep 2021 Deadline(s): 25 Jan 2022				
HORIZON-CL4-2021-RESILIENCE-02-32	IA	10.00 [83]	Around 2.50	4
Overall indicative budget		10.00		

General conditions relating to this call

[81] 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.

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

[83] Of which EUR 5.55 million from the 'NGEU' Fund Source.

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

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

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-RESILIENCE-02-32: Social and affordable housing district demonstrator (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Innovation Actions

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 in the Renovation Wave communication*[84] following a smart neighbourhood approach and providing blueprints for replication, setting

[84] *https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662*

liveability and latest technological and social innovations at the forefront;

- Mobilise cross-sectoral industrial[85] and partnerships at local level to develop, adapt, design new processes, methods and technologies (e.g. energy efficiency, circular, modular building, smart living, eco-design etc.). 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”[86] 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 and the private sector in developing 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;
- Pilot circular construction methods taking into account the different industrial perspectives and value chains relevant for the renovation of the districts;

85 Refers to the 14 Industrial Ecosystems for Recovery

86 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.

- Apply and pilot innovative smart housing applications (at individual dwelling level) and general smart grid or district-level energy, waste, water, storage and other 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 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;

- This topic supports the Bauhaus Initiative as lighthouse districts could display the application of the New 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 2022

HORIZON-CL4-2022-RESILIENCE-01

Conditions for the Call

Indicative budget(s)[87]

Topics	Type of Action	Budgets (EUR million) 2022	Expected EU contribution per project (EUR million)[88]	Number of projects expected to be funded
Opening: 12 Oct 2021 Deadline(s): 30 Mar 2022				
HORIZON-CL4-2022-RESILIENCE-01-01	RIA	25.30 [89]	6.00 to 8.00	4
HORIZON-CL4-2022-RESILIENCE-01-02	RIA	14.00	Around 14.00	1
HORIZON-CL4-2022-RESILIENCE-01-03	CSA	2.40	Around 2.40	1
HORIZON-CL4-2022-RESILIENCE-01-04	IA	15.00	Around 5.00	3
HORIZON-CL4-2022-RESILIENCE-01-05	RIA	13.50	Around 13.50	1
HORIZON-CL4-2022-RESILIENCE-01-06	IA	36.00 [90]	Around 12.00	3
HORIZON-CL4-2022-RESILIENCE-01-07	IA	36.00 [91]	Around 12.00	3
HORIZON-CL4-2022-RESILIENCE-01-08	RIA	13.50	Around 4.50	3
HORIZON-CL4-2022-RESILIENCE-01-10	RIA	20.00	3.00 to 5.00	4

87 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.

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

89 Of which EUR 20.76 million from the 'NGEU' Fund Source.

90 Of which EUR 31.14 million from the 'NGEU' Fund Source.

91 Of which EUR 31.14 million from the 'NGEU' Fund Source.

HORIZON-CL4-2022-RESILIENCE-01-11	RIA	20.00	3.00 to 5.00	5
HORIZON-CL4-2022-RESILIENCE-01-12	RIA	20.00	4.00 to 6.00	4
HORIZON-CL4-2022-RESILIENCE-01-13	RIA	20.00	3.00 to 5.00	3
HORIZON-CL4-2022-RESILIENCE-01-14	IA	21.00	6.00 to 8.00	6
HORIZON-CL4-2022-RESILIENCE-01-16	IA	21.00 [92]	5.00 to 7.00	3
HORIZON-CL4-2022-RESILIENCE-01-19	RIA	18.00	4.00 to 6.00	3
HORIZON-CL4-2022-RESILIENCE-01-20	IA	34.00 [93]	10.00 to 12.00	3
HORIZON-CL4-2022-RESILIENCE-01-21	CSA	4.50	Around 4.50	1
HORIZON-CL4-2022-RESILIENCE-01-23	RIA	20.00	3.00 to 5.00	4
HORIZON-CL4-2022-RESILIENCE-01-24	RIA	23.00	4.00 to 6.00	4
HORIZON-CL4-2022-RESILIENCE-01-25	IA	15.00	4.00 to 5.00	1
HORIZON-CL4-2022-RESILIENCE-01-26	CSA	10.00 [94]	Around 5.00	2
Overall indicative budget		402.20		

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

[92] Of which EUR 18.16 million from the 'NGEU' Fund Source.
[93] Of which EUR 29.41 million from the 'NGEU' Fund Source.
[94] Of which EUR 6.05 million from the 'NGEU' Fund Source.

Agreements	

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 (Processes4Planet Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 25.30 million.
Type of Action	Research and Innovation Actions

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.
- Consider the co-design of learning resources together with local and regional educational organisations for current and future generations of employees, with the possibility of integrating them in existing curricula and modules for undergraduate level and lifelong learning programmes. Learning resources should integrate the identification of new skills and should propose innovative learning-teaching methods that meet regional social needs and have a high potential for replication.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. Proposals should contribute to standardisation, wherever possible.

This topic implements the co-programmed European partnership Processes4Planet.

Raw materials for EU open 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 14.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 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 three-dimensional 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[95] compliant and made available through the European Marine Observation and Data Network (EMODnet).

For each of the three mineral deposits (polymetallic nodules, manganese crusts and sulphide deposits) found at different depth ranges of the ocean 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 constrains;
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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[95] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

Indicative budget	The total indicative budget for the topic is EUR 2.40 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, or security, namely to reconcile the increasing demand for critical raw materials for achieving climate-neutrality with nature protection, restoration and biodiversity growth and the need to exchange good practices in extractive activities permitting procedures with national and regional authorities, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.

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 States.

Scope: Reconciling the increasing demand for Critical Raw Materials necessary for the EU climate neutral ambition, with nature protection, restoration and biodiversity enhancement, 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. Particular attention will have to be paid to the legal obligations and practices ensuring compliance with EU nature legislation (Birds and Habitats Directives) and the goals of the EU Biodiversity Strategy for 2030.

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 analyses (including on the most affected raw materials, categories of sites, pressures, impact assessment methods, mitigation and compensation measures etc.) and training material; organise capacity-building workshops and seminars for competent authorities, industry and civil society in different Member States and other countries in Europe. These activities can also address other countries that are eligible to participate.

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.

Proposals should take into account issues of accessibility and inclusivity, such as age, gender, disability, and socio-economic background.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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 using digital platforms to address their needs while protecting biodiversity and raising awareness, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 6-7 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, 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;
- Develop business models and operation models.
- 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[96] compliant, help data gathering at EU level for evaluating the performance and competitiveness of extractive industries.

[96] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

Building on past projects, the actions should provide practical and easily applicable capacity building and training materials for a better environmental and social 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.

Proposals should take into account issues of accessibility and inclusivity, such as age, gender, disability, and socio-economic background.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 13.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply:

	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 increasing sustainable and responsible sourcing of primary and secondary raw materials and by using technological solutions to improve supply chain data transparency and traceability, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	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;
- Set up technological solutions for tracking raw material flows (material passports);
- Identify and address gaps in due diligence;
- Develop comparable criteria, reporting and audit approaches;
- 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.[97]

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. In order to achieve the expected outcomes, it is advised to involve industrial users from the downstream side. Due diligence has numerous research gaps in this

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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 five complex supply chains, including a batteries value chain.

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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply:

	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 increasing sustainable and responsible sourcing of primary and secondary raw materials and by using sustainable, smart, efficient and environmentally friendly technologies, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 6-7 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, 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;
- 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.[98]

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Scope: Actions should contribute to applying, adapting and eventually 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. Actions should 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 should target minerals and metals and 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.

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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

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 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.

Proposals should take into account issues of accessibility and inclusivity, such as age, gender, disability, and socio-economic background.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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 increasing access to primary and secondary raw materials by using innovative solutions for higher recovery rates and minimal environmental impact, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	Activities are expected to achieve TRL 6-7 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:

- 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.[99]

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 recovery rates of valuable by-products[100], particularly critical raw materials[101]. 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. For TRLs 6-7, a credible strategy to achieve future full-scale manufacturing in the EU is expected, indicating the commitments of the industrial partners after the end of the project.

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.

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100 The term "by-products" should be interpreted here as the constituents usually accompanying the major component(s) of a raw material at low concentrations.

101 EU list of critical raw materials 2020 – add link when published

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).

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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). 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 increasing sustainable sourcing of primary raw materials by using Earth Observation technologies for environmental monitoring, participation to the topic is limited to legal entities established in Member States, associated countries, OECD countries, African Union Countries, and MERCOSUR, CARIFORUM, and Andean Community. Proposals including legal entities which are not established in these countries will be ineligible. The above exception is aligned with the Communication (2020) 474 on Critical Raw Materials Resilience, on the need to develop strategic international partnerships on raw materials.
Technology Readiness Level	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:

- Unlock the potential of Earth Observation technologies, including Copernicus, through the development of downstream products and services for the whole mining life cycle,
- Strength 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.[102]

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.

These developments and innovations should be built upon Copernicus satellite constellations, and/or European national and commercial satellite missions, including, e.g. COSMO-Skymed, EnMAP, PRISMA, TerraSAR-X, 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, SAR and in situ data permitting to systematically revise and update pre-

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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 and mining monitoring:

- improved maps and techniques to map potential target areas of critical raw materials
- improved maps of mining waste deposits
- improved seabed mineral mapping by exploring the connection between sea shore and coastal areas
- Ground instability maps
- improved maps of mining waste deposits
- Mineral stockpile volume estimation
- Acid mine drainage maps

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Green and Sustainable Materials

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-RESILIENCE-01-10: Innovative materials for advanced (nano)electronic components and systems (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.

Type of Action	Research and Innovation Actions
Technology Readiness Level	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 enhanced and new functionalities and improved performance enabling added value to the European industry in sectors such as healthcare and wellbeing, mobility and transportation, aeronautics, environment monitoring, security and safety energy, smart cities, smart textiles and manufacturing;
- Impacts are also envisaged to smart grids, efficient through life performance monitoring, smart manufacturing and 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.

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, including advanced methods of data driven materials design, for e.g. 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 aluminium oxide, etc.) for miniaturised sensor and actuator modules.

Proposals should indicate the key quantitative specifications to be achieved and develop demonstrator components/systems to showcase the desired functionalities together with the increased efficiency, reliability and manufacturability. Proposals are also expected to prove the industrial relevance of the intended approach, establishing links to applications likely to benefit from the development. End-of-life issues should be addressed.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This 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-CL4-2022-RESILIENCE-01-11: Advanced lightweight materials for energy efficient structures (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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), joining technologies between composites and other 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 (energy, infrastructures, aeronautics, space) applications and in surface transport;
- Reduction in CO_2 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 which comply with industrial demands for quality and reliability. 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 are 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, self-monitoring, 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This 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-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.

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;
- Recycling aspects of multimaterial components and structures should also be addressed in detail.
- Joint development with material suppliers and end-users is required for a rapid uptake by industry;
- Modelling, simulation, standardisation and regulatory aspects (especially safety and nano-safety) and the process and materials qualification.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This 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-CL4-2022-RESILIENCE-01-23: Safe- and sustainable-by-design organic and hybrid coatings (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology	Activities are expected to start at TRL 3 and achieve TRL 5 by the end

Readiness Level	of the project – see General Annex B.

Expected Outcome: Development of organic and hybrid coatings, safe- and sustainable-by-design production strategies with enhanced functionality. This includes organic and hybrid 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 or hybrid 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 and techniques (e.g. nanostructured 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 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.

The proposals, activities and approaches should cover both - specific considerations for the organic and hybrid 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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.

This 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 for the benefit of society and the environment and materials for climate neutral 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

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 or if relevant, improved bioactivity and/or biodegradability; physiological and biomechanical constraints and implications should also be considered.
- 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, bioinks for bioprinting platforms, 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 or micro systems 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This 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-CL4-2022-RESILIENCE-01-14: Membranes for gas separations - membrane distillation (IA)

Specific conditions

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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.
- End-of-life issues

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 modelling 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. CO_2 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 CO_2 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).

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

This 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-CL4-2022-RESILIENCE-01-16: Building and renovating by exploiting advanced materials for energy and resources efficient management (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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 CO_2 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 CO_2 emissions by about 5%;

- Compared to state of the art materials and components, the newly developed materials should deliver:
    - Reduction by at least 30% of the embodied energy and CO_2 at component level;
    - Improvement by at least 20% of insulation properties;
    - Reduction by at least 15% of the total costs compared to existing solutions;
    - Demonstration of at least a 5% reduction of the energy spent during the whole life cycle of a building.
    - Increased durability and lifetime, lower maintenance costs and environmental footprint.
- 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 should 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 CO_2 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 should 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 should 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 should 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

The topic is open for international cooperation, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed[103]

HORIZON-CL4-2022-RESILIENCE-01-24: Novel materials for supercapacitor energy storage (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

[103] SWD(2021)97 final, Report on the protection and enforcement of intellectual property rights in third countries (2021)

	selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 23.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 6 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

Synergies are possible with any relevant projects from topic HORIZON-CL5-2022-D3-01-11 from Cluster 5, and respective cooperation activities are encouraged, however R&I on energy system integration, compatibility of systems or standards for participation in flexibility market is excluded.

The topic is open for international cooperation, while excluding industrial competitors from countries where the safeguarding of IPRs cannot be guaranteed[104]

Materials and data cross-cutting actions

Proposals are invited against the following topic(s):

[104] SWD(2021)97 final, Report on the protection and enforcement of intellectual property rights in third countries (2021)

HORIZON-CL4-2022-RESILIENCE-01-19: Advanced materials modelling and characterisation (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 18.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 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;
- Develop characterisation techniques supporting key European technology area strongholds. The developed characterisation methods should be complemented with and validated by modelling tools;
- Enable a model-based innovation processes covering all stages from materials design (including several scales, e.g. from molecular to macroscale) to product development, including validation, characterisation and life cycle assessment, with the aim, in particular, of translating industry needs into innovation challenges 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 and/or simulation;

- 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, models and simulation tools 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;
- Projects should contribute to the objectives of the European Materials Characterisation Council (EMCC) and European Materials Modelling Council (EMMC) and foresee the necessary resources to this effect.

HORIZON-CL4-2022-RESILIENCE-01-20: Climate Neutral and Circular Innovative Materials Technologies Open Innovation Test Beds (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 34.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

HORIZON-CL4-2022-RESILIENCE-01-25: Optimised Industrial Systems and Lines through digitalisation (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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 SMEs[105].

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;

[105] https://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises.

- 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;
- 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.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination.

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 Digital Technologies (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 4.50 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Connecting European stakeholders ecosystems, including SMEs, with European and International standardisation bodies and other relevant actors. Identification of standardisation areas, amongst others within the field of Internet standardisation, 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 ICT standardisation, ensuring promotion of European requirements, values and interests;
- Set-up of a facility to support participation of European specialists in international ICT Standard Developing Organisations and global fora and consortia;
- Increase the participation of European specialists in international ICT Standardisation activities to support European values and interests, including in leadership positions;
- Synergies with other similar initiatives or European players including from EU (and national) funded R&I projects;
- Increase awareness and education on sustainability and ICT standardisation;
- Support standardisation meetings in Europe, so that European players have easier conditions for participation.

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.

The aim is to reinforce the presence of EU and associated states experts in the international ICT standardisation scene, by setting up a ICT 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 ICT standardisation, including identification of sectors and areas, especially within the field of internet standardisation, where additional presence of EU and Associated Country 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 European Partnerships;

- The consortium will define the process for an open call allowing the funding of the key European specialists to participate in global 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 ICT standardisation, especially for European industry competitiveness, driving sustainability, sovereignty, green deal, values and ethics. The proposal will also include actions, including development of tools and materials, to promote education on ICT standardisation;

- The proposal should take into account the previous activities carried out 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).

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

HORIZON-CL4-2022-RESILIENCE-01-26: 'Innovate to transform' support for SME's sustainability transition (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: In order to achieve the expected objectives and/or the specific policy requirements of the topic, the consortium must include at least three entities from at least three Member States or Associated Countries. The following additional eligibility criteria apply: For actions funded under this topic, the same legal entity may only be the coordinator of one action. This means that any legal entity that is the coordinator of the consortium may receive only one grant under this topic. In case the same legal entity is the coordinator in more than one proposal submitted under this topic, only the last submitted proposal will be considered for evaluation. The coordinator of a consortium selected for funding under this topic may also not be the coordinator in actions funded under the topic HORIZON-CL4-2021-RESILIENCE-01-29: 'Innovate to transform' support for SME's sustainability transition (CSA).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 50 000.

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 technologies[106], 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.

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 (in cooperation with EU funded IP support),[107] technology transfer, adaptation to standards, adaptation to environmental rules, design management, skill

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106 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

107 https://intellectual-property-helpdesk.ec.europa.eu/index_en; https://intellectual-property-helpdesk.ec.europa.eu/horizon-ip-scan_en; https://euipo.europa.eu/ohimportal/en/online-services/ideas-powered-for-business

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 through calls for SMEs, to implement the elaborated recommendations.

This should support amongst other activities 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.

The Commission estimates that at least half of the budget should be allocated to financial support to SMEs in the form of third party financing.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

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

HORIZON-CL4-2022-RESILIENCE-02-PCP

Conditions for the Call

Indicative budget(s)[108]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution	Number of projects

[108] 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.

		2022	per project (EUR million)[109]	expected to be funded
Opening: 12 Oct 2021 Deadline(s): 30 Mar 2022				
HORIZON-CL4-2022-RESILIENCE-02-01-PCP	PCP	9.00 [110]	Around 9.00	1
Overall indicative budget		9.00		

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

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

Proposals are invited against the following topic(s):

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

[110] Of which EUR 5.38 million from the 'NGEU' Fund Source.

HORIZON-CL4-2022-RESILIENCE-02-01-PCP: Boosting green economic recovery and open strategic autonomy in Strategic Digital Technologies through pre-commercial procurement (PCP action)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Pre-commercial Procurement
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The specific conditions for actions with PCP/PPI procurements in section H of the General Annexes apply to grants funded under this topic.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: PCP/PPI procurement costs are eligible. The specific conditions are described in General Annex H.

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 open 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 open strategic autonomy, PCPs can make a key contribution to economic recovery and growth[111]. As the future is one of green digital growth[112], 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 solutions[113]. 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)[114]. 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 community[115] as well as public procurers[116] 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

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111 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 open strategic autonomy.
PCP showcases: see e.g. impacts of PCPs that commercialised greener solutions

112 'public authorities need to lead by example…', Green deal communication, December 2019

113 '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

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

115 Startup Europe Summit recommendations, March 2019

116 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.

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. They should 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 should 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement

DESTINATION – 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 research, education, 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[117], 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.

[117] https://ec.europa.eu/digital-single-market/en/news/sme-panel-consultation-b2b-data-sharing

- 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, network science, statistics, natural language understanding, mathematics, particle physics, astronomy, earth observation…), 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.

- 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.

In line with Europe's data, green and industrial strategies, for capitalising on the paradigm shift to the edge, Europe needs to pool major investments. Focus must be on the development and deployment of the next generation computing components, systems and platforms that enable this transition to a compute continuum with strong capacities at the edge and far edge in an energy efficient and trustworthy manner.

The overall objective of the topics in this heading is to establish the European supply and value chains in cloud to edge computing to Internet of Things (IoT) 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 the data economy required to support future hyper-distributed applications.

Finally, actions on high-end computing for exascale performance and beyond will be entirely implemented in the Joint Undertaking EuroHPC.

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 such actions 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.

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, digital for clean energy).

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

Call	Budgets (EUR million)		Deadline(s)
	2021	2022	
HORIZON-CL4-2021-DATA-01	141.00		21 Oct 2021
HORIZON-CL4-2022-DATA-01		205.00	05 Apr 2022
Overall indicative budget	141.00	205.00	

Call - WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2021

HORIZON-CL4-2021-DATA-01

Conditions for the Call

Indicative budget(s)[118]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[119]	Number of projects expected to be funded
Opening: 22 Jun 2021 Deadline(s): 21 Oct 2021				
HORIZON-CL4-2021-DATA-01-01	RIA	52.00 [120]	8.00 to 11.00	5
HORIZON-CL4-2021-DATA-01-03	IA	30.00	Around 5.00	6
HORIZON-CL4-2021-DATA-01-05	RIA	54.00	8.00 to 12.00	5
HORIZON-CL4-2021-DATA-01-07	CSA	3.00	Around 1.50	2
HORIZON-CL4-2021-DATA-01-08	CSA	2.00	Around 2.00	1
Overall indicative budget		141.00		

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

118 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.

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

120 Of which EUR 30.91 million from the 'NGEU' Fund Source.

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

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 (AI, Data and Robotics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 52.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 in data spaces, across the data life cycle.

Scope: Digital technologies, methods, architectures and processes for user-friendly, safe, trustworthy, compliant, fair, transparent, accountable and environmentally sustainable

collection, storage, processing, querying, analytics and delivery of data. The technologies should facilitate sharing and manipulation of data in compliance with prevailing and emerging legislation (e.g. GDPR) for data processors and data subjects/rightholders and other stakeholders. The technologies and solutions should enable safe and secure data handling, sharing and re-use in the context of common European data spaces in various situations and application areas. The scope also includes the combination of technological and social innovation, 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 should liaise with relevant cyber-security actions under Cluster 3. The actions are expected to build on Horizon 2020 actions on privacy-preserving technologies and liaise with appropriate actions from Horizon 2020 topic ICT-13-2018-19, as well as with data-centric H2020 European Research Infrastructures. They should 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 should liaise with other relevant national, regional and trans-national initiatives such as Gaia-X and EOSC, especially to ensure interoperability and reasonable re-use of common reference models, processes and building blocks for a pan-European data infrastructure.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership on Artificial Intelligence, Data and Robotics.

HORIZON-CL4-2021-DATA-01-03: Technologies for data management (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 8 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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, synthetic data generation, 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, privacy and integrity, especially in the context of data spaces.

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 should support a holistic approach of the data life cycle and comply with accountability, fairness and confidentiality as well as the FAIR principles (Findable, Accessible, Interoperable, Reusable) for data and metadata management. Building on results of relevant past and current initiatives, data management tools, systems and processes are expected to 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. The actions are expected to create links with relevant initiatives collecting/using heterogeneous/linguistic data, including AI initiatives (such as AI4EU, European Language Grid, or the projects from the H2020 topic ICT-48), and liaise with standardization bodies, where appropriate.

Actions are expected to deal with gaps and needs identified in real-world data space management and 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, reliable and automated annotation of unstructured data sources. The tools should 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 and social innovation. The tools should be demonstrated by diverse use cases. Provision of open source tools is encouraged to contribute to outreach and impact.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership on Artificial Intelligence, Data and Robotics.

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: Meta Operating Systems (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 54.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 150 000 in order to allow third parties to support industry, in particular SMEs, in take-up of emerging edge topologies, for populating and validating relevant use cases through experiments.

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

- Next generation of higher-level (meta) operating systems for the smart Internet of Things with strong computing capacity at the smart device, system and edge-level, embedded in a compute continuum from IoT-to-edge-to-cloud. Such Operating system should be device independent and implement advanced concepts such as ad-hoc clouds, time-triggered IoT, and decentralised intelligence.

- Increasing European autonomy in data processing required to support future hyper-distributed applications by building open platforms and an open edge ecosystem including business models, driven by European actors.

- Achieving trust in these (meta) operating systems among actors in diverse industrial ecosystems by leveraging open standards and - where applicable - open source.

- Emergence of an open edge ecosystem including midcaps, SMEs and start-ups that foster the up-take of an edge operating system, e.g. through a modular functional spectrum of executable apps and services, for nurturing a European network of innovators and developers.

- Demonstrators in 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 such as adhoc - cloud/fog communication not limited to 5G , the objective is to develop meta 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 training and 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, to optimise the CO_2 footprint and benefit from the use of renewable energy sources. Validation should be done through proof of concept or prototype implementations for at least 3 different applications in domains such as mobility, logistics, manufacturing, energy and other utilities, buildings or farming.

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 150.000 per third party for the entire duration of the action.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DATA-01-07: Coordination and Support of the 'Cloud-Edge-IoT' domain (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Coordination and Support Actions

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

- Supporting the Commission and the constituency in coordinating the proposal portfolio in particular resulting from HORIZON-CL4-2021-DATA-01-05, HORIZON-CL4-2022-DATA-01-02, and HORIZON-CL4-2022-DATA-01-03 and ensure consistent exploitation of the outcomes.

- Exploring and exploiting synergies between relevant European national and private initiatives from Cloud to edge to IoT.
- Regaining European competitiveness in internet infrastructures through effective partnership models and the provisioning of open solutions as well as trusted & interoperable data-driven services in the core and at the edge.

Scope:

- to coordinate with the evolution of the computing continuum 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, synchronisation of digital twins 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.
- 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DATA-01-08: Roadmap for next generation computing and systems technologies (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposal 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Call - WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2022

HORIZON-CL4-2022-DATA-01

Conditions for the Call

Indicative budget(s)[121]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[122]	Number of projects expected to be funded
		2022		
Opening: 23 Nov 2021 Deadline(s): 05 Apr 2022				
HORIZON-CL4-2022-DATA-01-01	RIA	33.00	8.00 to 12.00	3
HORIZON-CL4-2022-DATA-01-02	RIA	50.00 [123]	4.00 to 6.00	10

121 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.

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

123 Of which EUR 42.38 million from the 'NGEU' Fund Source.

HORIZON-CL4-2022-DATA-01-03	RIA	40.00	4.00 to 8.00	5
HORIZON-CL4-2022-DATA-01-04	IA	52.00	10.00 to 13.00	4
HORIZON-CL4-2022-DATA-01-05	RIA	30.00	Around 5.00	6
Overall indicative budget		205.00		

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

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 (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 13.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 52.00 million.

Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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, user-friendly, compliant and energy-efficient way; promote the development of a European industrial ecosystem of the data economy capable of ensuring digital autonomy; develop training material to endow workers in this occupational group with the right skillset in order to deploy the new technologies

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, data-centric H2020 European Research Infrastructures), as appropriate. The actions should contribute to European technological autonomy in data sharing.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership on Artificial Intelligence, Data and Robotics.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 33.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

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

- Improving 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) or action planning, as well as demonstrating how these improvements can have great positive impacts for society, people, economy, or the environment

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/extreme variations in values) 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 otherwise 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. The use of European data sources (such as Copernicus, Galileo/EGNOS for satellite data) is encouraged in the use cases, where appropriate. *Analytics* should be transparent, trustworthy, 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 (considering context), 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DATA-01-05: Extreme data mining, aggregation and analytics technologies and solutions (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.

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

- provide better technologies, tools and solutions 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/decentralized systems), in particular IoT, industrial, business, administrative, environmental, scientific or societal data.

Scope: The actions under this topic are expected to provide ground-breaking advances in the performance, speed and/or accuracy as well as 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/extreme variations in

values). The technologies and solutions are expected to discover and distil meaningful, reliable and useful data from heterogeneous and dispersed/scarce sources and deliver it to the requesting application/user with minimal delay and in the appropriate format. In particular, the advances should enable the development of trustworthy, accurate, green 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 should take into account the relevant human aspects and interactions with users.

The actions should address the integration of relevant technologies (e.g. big data, AI, IoT, HPC, edge/fog/cloud computing, language technologies, cybersecurity, telecommunications, autonomous systems etc.) 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). The use of European data sources (such as Copernicus, Galileo/EGNOS for satellite data) is encouraged in the use cases, where appropriate.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 50.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 5 by the end of the project – see General Annex B.

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

- A new AI-enabled Cloud-edge framework (Cognitive Cloud) 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 secure adaptability of services from cloud to edge to diverse users and contexts. Resource management should take into account the openness and trustworthiness of the underlying resource management layers. 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. The framework will also dynamically adapt the processing capacity of the cloud to the varying supply of green energy in order to optimise its environmental footprint. 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 (i.e., connectivity, computing & storage) 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, transparent and trustworthy 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, interoperability models and open platforms) should be considered where appropriate.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DATA-01-03: Programming tools for decentralised intelligence and swarms (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 5 by the end of the project – see General Annex B.

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

- Agile and secure architectures for collaborative smart nodes with decentralised or swarm 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 and dynamic groups of 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 systems (sensors and devices) integrated in an evolving Internet of Things and cyber-physical ecosystems 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 energy-efficient, lightweight AI-based approaches, tools for decentralised device and edge intelligence, innovative mesh architectures with mixed topologies to support concepts like tactile internet and swarm intelligence. This should support a paradigm shift from programming environments for individual devices to dynamic groups of devices like swarms. Research should include actionable data streams, contextual interaction and data fusion between the users and the objects as well as. analytical model distribution, delocalized computation and new mesh architectures. Concepts should combine advances in smart sensor networks, new generations of embedded processors, and operating systems for the edge with seamless federation of object identities (IDs) and distributed operation of a large number of heterogeneous IoT devices and smart systems to achieve higher resilience, security and trust in embedded AI applications. Proof of concept or prototype implementations should validate the concepts in at least 3 application areas like for example automated driving, health, farming, smart factories, utilities, cities and communities, logistics, buildings, which in future require more power on device-level at the edge. Concepts should also contribute to the sustainable use of energy, by optimising energy efficiency of proposed solutions and promoting the use of renewable energy. Contributions to sustainable development goals (SDGs) and open source, if appropriate.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

DESTINATION – 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:

- **Open strategic autonomy 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 build 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 and production plants and equipment, telecom networks, aerospace vehicles, consumer products

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. Main actions on 6G technologies will be undertaken in the Smart Networks and Services Joint Undertaking.

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.

In line with the vision set out in the Digital Decade Communication (COM(2021)118), in particular its 'secure and performant sustainable digital infrastructures' pillar, actions under this Destination will support Europe's open 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 open 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 under this work programme address in particular the need to develop micro electronic components and systems supporting future disaggregated Radio

Access Networks and components enabling the advent of all optical networks for ultra low consumption and ultra high security networks.

Proposals are invited under the topics of this heading in this work programme and under the topics of the 'Smart Networks and Services" Joint Undertaking addressing the future connectivity platforms including edge cloud and IoT technologies.

- 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 potential[124]. 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.

Several topics 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, agri-food[125], forestry, inspection and maintenance, logistics, construction,

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124 See https://www.mckinsey.com/featured-insights/artificial-intelligence/tackling-europes-gap-in-digital-and-ai (based on data from 2017 and 2018)

125 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.

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.

Several topics of this heading are under the co-programmed Partnership 'AI, Data and Robotics'.

- European leadership in Emerging Enabling Technologies

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 (SRA[126]) and its associated main Key Performance Indicators,[127] 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.

The aim of the Commission's Digital Decade strategy is for the EU to become digitally sovereign in an interconnected world, and in the coming years quantum technologies will be a key element of this digital sovereignty, as they are of global strategic importance. Quantum technologies will be also used, among others, for sensitive applications in the area of security, and in dual-use applications. Other world regions are already investing heavily in all areas of

126 https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=65402
127 Link to provide later

quantum technologies research. In this context, the EU must take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. This will enable it to safeguard its strategic assets, interests, autonomy and security, while advancing towards its goal of open strategic autonomy.

The Quantum Technologies Flagship conducts research and development activities in the key domains of quantum computing and simulation, quantum communication, and quantum sensing. The Flagship will contribute to world-leading quantum computers and simulators, that will be acquired by the European High Performance Computing Joint Undertaking, and will be crucial to achieving its Digital Decade goal of having its first computer with quantum acceleration by 2025, with a view to being at the cutting edge of quantum capabilities by 2030. These machines will have a profound impact, with applications in medicine, manufacturing, or new material and new drugs design but also in cryptography, finance and many other sensitive domains.

Moreover, the Flagship's research into quantum communication will support the development of a European quantum communication infrastructure (EuroQCI). This key component of the EU Cybersecurity Strategy will provide an extremely secure form of encryption to shield the EU's government data and critical infrastructures against cyber-attacks. Ensuring that the latest quantum communication technologies remain accessible in the EU is crucial to maintaining European security in the face of future threats.

Research in quantum sensing technologies is also vital to the EU's interests, as it will develop European expertise in quantum clocks for navigation (including for embarkation on Galileo satellites) and precise timing applications, sensors for autonomous vehicles, and the next generation of medical sensors.

It is therefore clearly in the EU's interests to protect European research in these domains, the intellectual property that it generates, and the strategic assets that will be developed as a result, while taking steps to avoid situations of technological dependency on non-EU sources (in line with the call of the October 2020 European Council to reduce Europe's strategic dependencies). With this in mind, the Commission has decided that, in the research areas covered by 12 actions in this work programme in quantum computing and simulation, communication, and sensing, only Associated Countries that meet certain conditions will be eligible to participate in these actions.

The eligibility to participate in such actions is limited to legal entities established in the EU, Norway, Iceland, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

- 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 3-5 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, 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 open strategic autonomy by sustaining first-mover advantages in strategic areas including AI, data, robotics, 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)
	2021	2022	
HORIZON-CL4-2021-DIGITAL-EMERGING-01	311.90		21 Oct 2021
HORIZON-CL4-2021-DIGITAL-	23.00	28.00	27 Jan 2022

EMERGING-02			
HORIZON-CL4-2022-DIGITAL-EMERGING-01		116.50	05 Apr 2022
HORIZON-CL4-2022-DIGITAL-EMERGING-02		127.00	16 Nov 2022
Overall indicative budget	334.90	271.50	

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)[128]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[129]	Number of projects expected to be funded
Opening: 22 Jun 2021 Deadline(s): 21 Oct 2021				
HORIZON-CL4-2021-DIGITAL-EMERGING-01-01	RIA	26.00 [130]	8.00 to 10.00	3
HORIZON-CL4-2021-DIGITAL-EMERGING-01-05	CSA	2.00	Around 2.00	1
HORIZON-CL4-2021-DIGITAL-EMERGING-01-06	IA	26.00	4.00 to 6.00	6
HORIZON-CL4-2021-DIGITAL-EMERGING-01-07	RIA	39.00	3.00 to 5.00	8
HORIZON-CL4-2021-DIGITAL-EMERGING-01-09	IA	27.00 [131]	3.00 to 5.00	7
HORIZON-CL4-2021-DIGITAL-EMERGING-01-10	IA	22.00	3.00 to 5.00	6
HORIZON-CL4-2021-DIGITAL-EMERGING-	RIA	44.50	Around	9

128 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.

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

130 Of which EUR 15.49 million from the 'NGEU' Fund Source.

131 Of which EUR 16.09 million from the 'NGEU' Fund Source.

01-11			5.00	
HORIZON-CL4-2021-DIGITAL-EMERGING-01-12	RIA	11.50	Around 11.50	1
HORIZON-CL4-2021-DIGITAL-EMERGING-01-13	CSA	2.50	Around 2.50	1
HORIZON-CL4-2021-DIGITAL-EMERGING-01-14	RIA	17.00	2.00 to 3.00	6
HORIZON-CL4-2021-DIGITAL-EMERGING-01-21	RIA	13.50	Around 6.75	2
HORIZON-CL4-2021-DIGITAL-EMERGING-01-23	RIA	4.00	Around 1.33	4
HORIZON-CL4-2021-DIGITAL-EMERGING-01-26	CSA	3.00	Around 3.00	1
HORIZON-CL4-2021-DIGITAL-EMERGING-01-27	RIA	22.50	5.00 to 7.00	4
HORIZON-CL4-2021-DIGITAL-EMERGING-01-30	RIA	10.00	Around 5.00	2
HORIZON-CL4-2021-DIGITAL-EMERGING-01-31	RIA	35.00	3.00 to 5.00	9
HORIZON-CL4-2021-DIGITAL-EMERGING-01-32	CSA	6.40	Around 6.40	1
Overall indicative budget		311.90		

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

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

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposals 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, signal processing, etc.

- New specialised processor designs may incorporate approaches such as neuromorphic, in-memory computing, probabilistic computing, neural networks, programmable logic, hardware-software co-design as well as open-source hardware and processor IP.
- Proposals 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.
- Proposals should include research on advanced hardware-based security at silicon-level.
- Proposals should take into account certification guidelines for secure and safety-critical applications where relevant.

Proposals should include a preliminary analysis of bringing successfully to the market the proposed research either as IP blocks or as standalone chips. Proposals may include early chip prototyping in well-justified cases.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-05: Open Source Hardware for ultra-low-power, secure processors (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposals 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 including certification guidelines for design of IP to be used in safe/secure applications
- Participate and lead in the development of open source hardware standards and specifications.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 35.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

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

- European leadership in the area of flexible, printed and organic electronics
- Development of new concepts, designs and technologies in electronics to support and enable circular economy and sustainability.
- 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 technologies[132]

to address the challenges and opportunities associated with green and digital transformation. Eco-design principles[133],

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 proposals will focus on 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). Proposals should address the improvement of system characteristics (e.g. performance, robustness, reliability) and progress in high throughput and 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) including in hybrid IC or 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

European Innovation Leadership in Photonics

Proposals are invited against the following topic(s):

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132 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.

133 Complying with the EU Ecodesign directive.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-06: Advanced optical communication components (Photonics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	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: Proposal 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: Proposals 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. Emerging solutions, e.g. based on free space optical communication may be explored as well.

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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership on Photonics.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-07: Advanced Photonic Integrated Circuits (Photonics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 39.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

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

- New generations of photonic integrated circuits and devices
- 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
- Providing European open strategic autonomy in Photonic Integrated Circuits and related manufacturing processing

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 and industrial 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 design, integration, 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 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 photodetectors (including arrays) and high-efficiency semiconductor lasers across many wavelength bands, capable of withstanding high temperatures (>85°C) depending on the intended application. Incorporation of new building blocks such as magneto-optic elements for non-reciprocal functionality (e.g. optical isolation) could also be included.

Proposals 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership for Photonics.

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

Expected Outcome: One proposal expected to contribute to all of the following expected outcomes:

- Establishment of a Europe wide platform addressing the Communication Network Technologies and systems in the context of 6G global developments. It supports 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 Europe's contribution to standards, and the identification of international cooperation priorities across key regions. The action is expected to directly contribute to support the early implementation of the new Smart Networks Services (SNS) institutionalised European partnership and the related programmatic organisation through cross SNS projects coordination.

Scope: The selected proposal covers:

- Stakeholder management towards R&I orientation and SNS cross-project coordination and cooperation (implementation of the cross project cooperation contractual clause);
- Europe wide cartography of relevant Smart Network initiatives and identification of strategic cooperation opportunity in particular with initiatives at Member States level
- Design and maintenance of a European network web site;
- Working groups management and organisation for issues of common interest, supporting a common EU 6G vision and its technological realisation;
- International cooperation support with key third countries. It includes identification of international cooperation strategies with clear benefits to EU industrial stakeholders;
- Support to organisation of key conferences and dissemination events, including the EUCNC yearly conference.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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 (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 27.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-5 and achieve TRL 6-7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but at least also to the highest ranked for each of the three expected outcomes (1. Resource

	optimisation and minimisation of waste, energy, or greenhouse gas emissions, 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.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As third parties' grants may include robotics components, requiring high equipment investment and/or important effort to integrate in a use-case to address the sectorial challenges, the maximum amount to be granted to each third party is EUR 200 000.

Expected Outcome: Proposal results are expected to contribute to at least one of the following expected outcomes:

1. Innovative AI, data and robotics solutions for resource optimisation and minimisation of waste in any type of sector (from agri-food, to energy, utilities, transport, production, etc.), reduction of energy consumption and greenhouse gas emissions including exploitation of all data and information sources contributing to optimising applications for a greener planet. This includes among others 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

2. 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.

3. 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, by addressing use-cases scenarios in actual or highly realistic operating environments, how they can directly contribute to the Green Deal. The proposed 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. The environmental impacts of the proposed solutions should also be taken into account when making the case for the added value of the technology for the environment.

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 in such applications. 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 (including SMEs), 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 proposals 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 Trustworthy and ethical AI.

To reach their objectives, all proposals are expected to exploit synergies between at least two of the three components: AI, Data and Robotics and forge strong cooperation between to corresponding practitioners.

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 and sensor driven AI for process optimisation) or only include non-robotics AI and Data (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; therefore, proposals should clearly specify their robotics demonstrator, if they chose to have one.

Proposals should clearly identify the expected outcome it will focus on.

Two types of proposals are expected:

1. Focused projects (EU contribution around EUR 3.00 million), involving the user industry and technology provider(s),

2. Larger projects (EU contribution around EUR 5.00 million), 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 all types of companies, but only SMEs and Start-ups[134] will receive financial support to third parties, with a

[134] *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 EUR €50 000 early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% financial support to third parties while other SMEs would receive 70% financial support. Startups would be expected to highlight the impact that the project will have on their overall*

maximum of EUR 200 000 per third party[135] and 70% funding (100% for start-ups). At least 40% of the requested amount should be dedicated to financial support to third parties. 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. Maximum one type of third party project will be funded per expected outcome[136].

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, must receive support from business experts, provided by the action, to further develop their business and develop their market reach, and maximise their business opportunities.

When possible, 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 platform[137], Digital Industrial Platform for Robotics[138], data platforms[139] 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.

If proposals use satellite-based earth observation, positioning, navigation and/or related timing services and data, they have to prioritise Copernicus and/or Galileo/EGNOS over equivalent competing solutions offering the same services/data.

All proposals are expected to allocate tasks to cohesion activities with the co-programmed partnership on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other European partnerships and Horizon Europe Clusters (Cluster 4 and Cluster 6 in particular) are encouraged.

This topic implements the co-programmed European Partnership on Artificial Intelligence, Data and Robotics.

Company strategy and growth prospects in the Impact section of their proposals (as well as the impact on society and European competitiveness.

135 Maximum amount per third party, received from a given action, over its entire duration

136 The 3 expected outcomes are : 1. Resource optimisation and minimisation of waste, energy or greenhouse gas emissions, 2. Environmental and waste management in the circular economy, 3. Robotics solutions in harsh environments serving the Green Deal

137 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

138 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

139 E.g.: https://www.big-data-europe.eu/

HORIZON-CL4-2021-DIGITAL-EMERGING-01-10: AI, Data and Robotics at work (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-5 and achieve TRL 6-7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but also to at least 2 highest ranked for each use-case, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As third parties' grants may include robotics components, requiring high equipment investment and/or important effort to integrate in a use-case to address the sectorial challenges, the maximum amount to be granted to each third party is EUR 200 000.

Expected Outcome: Proposal results are expected to contribute to at least one 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 trustworthy hybrid decision-making, and optimising their tasks

Scope: Proposals are expected to demonstrate how AI, data, robotics and automation solutions can support workers in their daily tasks, improving working conditions (both physical and social) 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/production or service relevant KPIs, demonstrators at TRL6-7, 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.

While the focus is on technology, a human-centred approach will be key, with involvement of the workers, professionals, (front-line operators and managers) and other relevant experts, such as experts in human-centred design. They will closely collaborate with the technology providers and integrators. Engagement with SSH[140] expertise is also needed to improve interaction design and to provide expertise on trustworthiness and acceptability by workers, as well as ethical perspective of human-machine collaboration. Gender and intersectionality dimension[141] analysis should be a part of the proposals, where relevant.

Each proposal will focus on one of the two following use-cases:

1. 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. The assistance should also take into account other factors less related with physical assistance like stress level. Meaningful human oversight of autonomy should be addressed.

2. 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 and explainability 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, User interface experience, for natural and seamless interaction between the human and the technology/sources of information, including Augmented/Virtual Reality when appropriate.

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140 Social Sciences and Humanities

141 https://en.wikipedia.org/wiki/Intersectionality - intersectional aspects could cover gender, age, social level, education, ethnic origin, etc.

Proposals should incorporate skills developments activities or/and connect with existing skills activities in that domain, as appropriate.

Proposals should clearly identify which of the two use-cases listed above they will focus on.

Two types of proposals are expected:

1. Focused projects (EU contribution around EUR 3.00 million), involving the user industry and technology provider(s),

2. Larger projects (EU contribution around EUR 5.00), 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 all types of companies, but only SMEs and Start-ups[142] will receive financial support to third parties, with a maximum of EUR 200 000 per third party[143] and 70% funding (100% for start-ups). At least 40% of the requested amount should be dedicated to financial support to third parties. 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. Maximum one type of third party project will be funded per use-case.

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, must receive support from business experts, provided by the action, to further develop their business and develop their market reach, and maximise their business opportunities.

When possible, 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 platform[144], Digital Industrial Platform for Robotics[145], data platforms[146] and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these

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142 *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 EUR €50 000 early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% financial support to third parties while other SMEs would receive 70% financial support. 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.*

143 Maximum amount per third party, received from a given action, over its entire duration

144 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

145 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

146 E.g.: https://www.big-data-europe.eu/

platforms in order to enhance the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other PPPs are encouraged.

This topic implements the co-programmed European Partnership on Artificial Intelligence, 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 (AI, Data and Robotics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 44.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposal results are expected to contribute to the following expected outcome:

- **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 interactive robots, with greatly improved intuitive, safe and efficient cognitive, social and physical capabilities, to assist humans.

In addition, depending on the focus of the proposal, the results are expected to contribute to at least one 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 and harsh environments,

and continuous human-physical interactions) and an increased level of autonomy over the current state of the art, necessary to address real-world problems, while ensuring safety and reliability.

- Smooth and trustworthy (including safety and reliability) human-robot collaboration through advanced reactivity and mutual understanding, and human-centric automated adaptation of robots in human-robot interactions.

Scope: Proposals are expected to develop technologies and systems that significantly enhance the cognitive ability of robots from the current state of the art to achieve greater levels of interaction and autonomy. Proposals will address as appropriate the following:

- 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 or advanced 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. Support from simulation tools could be considered, as appropriate.

- Increase robot acceptance by handling adequately both human and robotic actions, with human-centric, advanced behavioural and elaborated planning models, and adopting multidisciplinary approaches including SSH[147], as well as end-user involvement in the design of solutions addressing human factors and interaction. Gender and intersectionality dimension[148] analysis should be a part of the proposals, where relevant.

- Push the limits of robotics interaction, adopting an interdisciplinary approach to integrate methods and techniques that allow the machines to engage in physical interactions 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 fully integrating the human in the loop when performing a task; development of advanced control tools for dexterous and safe manipulation, assistance, and locomotion in diverse environments (ground, air, water, space, in-vivo and including safety critical and hazardous environments that are

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148 https://en.wikipedia.org/wiki/Intersectionality - intersectional aspects could cover gender, age, social level, education, ethnic origin, etc.

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.

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 such use-cases scenarios. Scientific and technological progress should be demonstrated by qualitative and quantitative KPIs, demonstrators, benchmarking and progress monitoring. Activities are expected to achieve TRL 4-5 by the end of the project

- The first type of proposals will further develop the **level of autonomy** in building 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**, verbal/non-verbal communication as well as robot-environment/object interaction, embedding, as appropiate, 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-centric behaviour by understanding of physiological responses and 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, safe 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 mechanisms[149] appropriate to the use case. Such proposals should adopt a multidisciplinary approach and involve the necessary expertise in SSH[150], in particular in ethics and human-centric design to enhance trust and acceptability.

When possible proposals should build on and reuse public results from relevant previous funded actions. Proposals should make use of connections to the Digital Innovation Hub

149 Explainability mechanisms can use multiple communication modalities, verbal, non-verbal, gestural etc.
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networks, particularly those in Robotics, Data and AI. Full use should be made of the common resources available in the AI-on-Demand platform[151], Digital Industrial Platform for Robotics[152], data platforms[153] 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.

All proposals should also take into consideration trustworthy AI principles[154] including respect of human dignity and agency, as appropriate, given the technology focus.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other PPPs are encouraged.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-12: European Network of Excellence Centres in Robotics (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 11.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 11.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 60 000.

151 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

152 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

153 E.g.: https://www.big-data-europe.eu/

154 https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai

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

- Scientific and technology advances in the major robotics challenges hampering its deployment
- A strong and tightly networked European research community in robotics, making it a world-class powerhouse for robotics excellence.

Scope: To ensure European open 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 Europe[155] and the coordinated action plan between the European Commission and the Member States and Associated Countries[156], 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[157], 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 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:

- Proposals should be driven by leading figures in robotics from major excellent robotics research centres, and industries, and bringing the best scientists distributed all over Europe, including also from promising research labs. 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.

155 https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe
156 https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6689
157 Covering robots with certain level of intelligence/autonomy in their behaviour

- 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.

Activities of the Network:

- 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, with a maximum of 60k€ per third party[158]).

- 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).

[158] Maximum amount per third party, received from a given Action, over its entire duration

- 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.
- Include sustainable access to the required resources and infrastructure to support R&D activities of the action, such as robotics equipment, support staff and engineers, and capacity to develop experiments that address the major future robotics challenges.

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 reference benchmarks 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 4-5 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[159] 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[160] 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

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160 https://en.wikipedia.org/wiki/Intersectionality - intersectional aspects could cover gender, age, social level, education, ethnic origin, etc.

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 platform[161] and Digital Industrial Platform for Robotics[162] 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. Openness and interoperability of components are encouraged to develop synergies and cross-fertilization between different approaches and solutions (e.g. through modularity of components or open interfaces).

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 other Networks of excellence centres in AI funded in H2020 or Horizon Europe, with a view of, all together, create vibrant European network of AI excellence centres. To that end, the activities should integrate with and complement the activities of the H2020-ICT-48 projects. The proposals are expected to dedicate tasks to ensure this coherence.

- With relevant activities in AI, Data and Robotics, primarily in destinations 3, 4 and 6, but also in other destinations and clusters, and share or exploit results where appropriate.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other PPPs are encouraged.

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	
Expected EU contribution per	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately.

[161] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

[162] https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

project	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.50 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposal 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 disciplines in science and engineering, RTOs, industry sectors, stakeholders) to meet, mutually inspire, cooperate and develop together innovative ideas for future enabling technologies from early stages on (i.e., TRL 3+). 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 national/regional 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 will 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).

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-14: Advanced spintronics: Unleashing spin in the next generation ICs (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 17.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 demonstrate specific advantages of the approach and 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, vortices, skyrmions) 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 behaviour 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-27: Development of technologies/devices for bio-intelligent manufacturing (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.50 million.
Type of Action	Research and Innovation Actions

Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 4 by the end of the project – see General Annex B.

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.

Proposals 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 constrains 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;

- Innovative metrology and characterisation required for development of the bio-inspired technical components and systems;
- 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.
- Innovative metrology and characterisation required for development of the bio-inspired technical components and systems

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-01-21: Next generation quantum sensing technologies (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.75 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's

	strategic assets, interests, autonomy, and security, participation in this topic is limited to legal entities established in Member States, associated countries, OECD countries and MERCOSUR countries. Proposals including legal entities which are not established in these countries will be ineligible. This decision has been taken on the grounds that, in the area of research covered by this topic, EU open strategic autonomy is particularly at stake. It is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[163]
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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.

[163] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Scope: Proposals should focus on next generation quantum sensors that provide extreme precision and accuracy measurements in many fields, beyond 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 Europe; for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-23: International cooperation with Canada (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.33 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 4.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply:

	In order to achieve the expected objectives of the action, namely reinforced EU-Canada research excellence in specific areas of mutual EU-Canada interest, including quantum computing and simulation, quantum networking and communication, quantum sensing and metrology, the consortium must include a team of Canadian researchers, with at least one (1) university applicant in Canada eligible to receive funding from the Natural Sciences and Engineering Research Council of Canada (NSERC). Researchers should refer to NSERC's Eligibility Criteria for Faculty to see if they are eligible to apply for and hold funds. Applicants in Canada must meet NSERC's Eligibility Criteria for Faculty and must agree to terms and conditions at the time of application and when accepting the award. Applicants must complete and sign the NSERC Terms and Conditions for Applying form and attach it to the proposal[164]
Technology Readiness Level	Activities are expected to start at TRL 1-2 and achieve TRL 2-3 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: Grants awarded under this topic will be jointly funded with NSERC. There will be only one joint procedure for selection and evaluation of proposals to be conducted in accordance to the Horizon Europe procedures. Proposals will be assessed by an evaluation committee with balanced participation of experts appointed by the Commission and NSERC. Applicants should submit the proposal only through the EU Funding & Tenders Portal. Evaluation Summary Reports will be shared with NSERC.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Grants awarded under this topic will be linked to the corresponding grant agreements signed by NSERC as Alliance Grants.

Expected Outcome: Joint EU – Canada proposals are expected to contribute to the following outcomes:

[164] Canadian applicants should refer to the NSERC website under the Call description for the NSERC Terms and Conditions for Applying form: https://www.nserc-crsng.gc.ca/Innovate-Innover/Collaborative_Research-Recherche_Collaborative_eng.asp

- 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 for the Joint Call EU-Canada 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.

The Commission and NSERC consider that proposals with duration of 36 months (but not exceeding 60 months) would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations.

This is a Joint Call EU-Canada. The total indicative budget for the topic is EUR 8.00 million (approximately CAD 12.00 million[165]) (sum of the EU indicative budget for the topic and the

[165] Exchange rate of 4th May 2021 applied

Canadian indicative budget for the topic, which is also EUR 4.00 million (approximately CAD 6.00 million[166]). The expected Canadian contribution per project is around EUR 1.33. million (approximately CAD 2.00 million[167]). The total expected contribution per project is EUR 2.66 million (approximately CAD 4.00 million[168]). Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

The funding from NSERC will be provided to eligible applicants in Canada only and the EU funding only to legal entities established in eligible countries in accordance with General Annex B.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-30: Investing in new emerging quantum computing technologies (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, participation in this topic is limited to legal entities established in Member States, associated countries, OECD countries and MERCOSUR countries. Proposals including legal entities which are not established in these countries will be ineligible. This decision has been taken on the grounds that, in the area of research covered by this topic, EU open strategic autonomy is particularly at stake. It is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions.

166 Exchange rate of 4th May 2021 applied
167 Exchange rate of 4th May 2021 applied
168 Exchange rate of 4th May 2021 applied

	For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[169]
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposals 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, 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, photonic qubits, and spin 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

[169] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 HORIZON-CL4-2022-DIGITAL-EMERGING-01-10: Strengthening the quantum software ecosystem for quantum computing platforms), 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 Europe; for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-01-32: Support and coordination of the Quantum Technologies Flagship Initiative (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.40 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, participation in this topic is limited to legal entities established in Member States, associated countries, OECD countries and MERCOSUR countries. Proposals including legal entities which are not established in these countries will be ineligible. This decision has been taken on the grounds that, in the area of research covered by this topic, EU open strategic autonomy is particularly at stake. It is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For the duly justified and exceptional reasons listed in the paragraph

	above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[170]

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

Coordination of the Quantum Technologies Flagship

- support the efficient functioning of the Quantum Technologies Flagship and the efficient implementation of the broader EU quantum strategy, and promote the Flagship's 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
- transfer Europe's research and innovation results into practical and high-value applications for the benefit of society.

Standardisation

- 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.

[170] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Education and training

- 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: Coordination of the Quantum Technologies Flagship

Proposals should ensure the smooth running and further development of the Flagship, support the implementation of the overall EU strategy in quantum technologies, including governance, raise the profile of the Flagship's 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, contribute to the overall EU strategy in the field (e.g. EuroQCI, EuroHPC), and share best practice, and to 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.

Proposals should include concrete activities to coordinate and streamline European industrial efforts in quantum technology to help unlock research from laboratories and forge a supply chain in Europe. Proposals should feature a plan enabling the translation of academic research in all Flagship pillars (quantum computing, quantum simulation, quantum communications, and quantum sensing and metrology) into practical quantum technology and applications.

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 in the field (e.g. academia, RTOs, and industry, including SMEs).

All proposals should contribute to spreading excellence across Europe; for example, through the involvement of Widening Countries.

Standardisation

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.

Education and training

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 take into account synergies with activities in advanced digital skills supported by the Digital Europe Programme.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Call - Digital and emerging technologies for competitiveness and fit for the green deal

HORIZON-CL4-2021-DIGITAL-EMERGING-02

Conditions for the Call

Indicative budget(s)[171]

Topics	Type of Action	Budgets (EUR million)		Expected EU contribution per project (EUR million)[172]	Number of projects expected to be funded
		2021	2022		
Opening: 02 Nov 2021 Deadline(s): 27 Jan 2022					
HORIZON-CL4-2021-DIGITAL-EMERGING-02-10	RIA		12.00	5.00 to 7.00	2
HORIZON-CL4-2021-DIGITAL-EMERGING-02-15	FPA				0
HORIZON-CL4-2021-DIGITAL-EMERGING-02-16	RIA		16.00	2.00 to 3.00	5
HORIZON-CL4-2021-DIGITAL-EMERGING-02-17	FPA				0
HORIZON-CL4-2021-DIGITAL-EMERGING-02-19	FPA				0

171 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.

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

HORIZON-CL4-2021-DIGITAL-EMERGING-02-20	IA	23.00		7.00 to 10.00	3
HORIZON-CL4-2021-DIGITAL-EMERGING-02-22	FPA				0
Overall indicative budget		23.00	28.00		

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

Flagship on Quantum Technologies: a Paradigm Shift

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-DIGITAL-EMERGING-02-15: Framework Partnership Agreement for developing the first large-scale quantum computers (FPA)

Specific conditions	
Type of Action	Framework Partnership Agreement
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of

	technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[173]

Expected Outcome: Framework Partnership Agreements (FPAs) in quantum computing are expected to establish a stable and structured partnership between the Commission 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.

173 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 will 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 NISQ [174] 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, including for hybrid quantum/HPC computing, and the capability of out-performing 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 scalability and capable of out-performing 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 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 and engineering 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.

[174] 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 HORIZON-CL4-2021-DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms), 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 Europe; for example, through the involvement of Widening Countries.

The partnership will have a duration of 4 years.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-16: Basic Science for Quantum Technologies (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, participation in this topic is limited to legal entities established in Member States, associated countries, OECD countries and MERCOSUR countries. Proposals including legal entities which are not established in these countries will be ineligible. This decision has been taken on the grounds that, in the area of research covered by this topic, EU open strategic autonomy is particularly at stake. It is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For the duly justified and exceptional reasons listed in the paragraph

	above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[175]
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 4 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 thermodynamic 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,

175 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 Europe; for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-17: Framework Partnership Agreement for developing large scale quantum simulation platform technologies (FPA)

Specific conditions	
Type of Action	Framework Partnership Agreement
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be

	demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[176]

Expected Outcome: Framework Partnership Agreements (FPAs) in quantum simulation are expected to establish a stable and structured partnership between the Commission 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 will 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

[176] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

(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 Europe; for example, through the involvement of Widening Countries.

The partnership will have a duration of 4 years.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-19: Framework Partnership Agreements in Quantum Communications (FPA)

Specific conditions	
Type of Action	Framework Partnership Agreement
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway,

	Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[177]

Expected Outcome: Framework Partnership Agreements (FPAs) in Quantum Communication Technologies are expected to establish stable and structured partnerships between the Commission 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 will 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:

[177] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

- 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-liked 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 Europe; for example, through the involvement of Widening Countries.

The partnership will have a duration of 4 years.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-20: Quantum sensing technologies for market uptake (IA)

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of between EUR 7.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

project	selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 23.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[178]

[178] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor

Technology Readiness Level	Activities are expected to start at TRL 4-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 Europe; for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA)

Specific conditions	
Type of	Framework Partnership Agreement

is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Action	
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[179]

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

[179] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 Commission 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 will 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 Europe; for example, through the involvement of Widening Countries.

The partnership will have a duration of 4 years.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.

Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[180]
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

[180] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Expected Outcome: Proposal 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 Europe; for example, through the involvement of Widening Countries.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Call - Digital and emerging technologies for competitiveness and fit for the green deal

HORIZON-CL4-2022-DIGITAL-EMERGING-01

Conditions for the Call

Indicative budget(s)[181]

[181] 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.

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[182]	Number of projects expected to be funded
		2022		
Opening: 21 Dec 2021 Deadline(s): 05 Apr 2022				
HORIZON-CL4-2022-DIGITAL-EMERGING-01-03	RIA	48.00	3.00 to 5.00	10
HORIZON-CL4-2022-DIGITAL-EMERGING-01-26	RIA	22.00	4.00 to 6.00	4
HORIZON-CL4-2022-DIGITAL-EMERGING-01-30	RIA	13.00	Around 13.00	1
HORIZON-CL4-2022-DIGITAL-EMERGING-01-35	RIA	17.50	2.00 to 3.00	5
HORIZON-CL4-2022-DIGITAL-EMERGING-01-38	CSA	3.00	Around 3.00	1
HORIZON-CL4-2022-DIGITAL-EMERGING-01-39	RIA	13.00	Around 13.00	1
Overall indicative budget		116.50		

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

182 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.
Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

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

Ultra-low power processors

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-26: Open source for cloud-based services (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 7 by the end of the project – see General Annex B.

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

- The objective of this topic is to complete the continuous path from flagship projects at the component level, such as the EPI, and cloud services. Emphasis is on the software and hardware interfaces between the aforementioned new processing architectures and cloud applications with the aid of relevant widely available ICT industry standards and Open Source stacks.

Scope: Proposals will address at least one of the following two areas:

- Virtual environments, methods and tools that interface with the deployment of full open source stacks from the kernel to cloud applications featuring targeted relevant processing architectures of European initiatives, e.g. RISC-V. Proposals addressing this field should cover both of these points:

  - Required developments to provide a simulation of the targeted architecture that allows validation, verification and testing of the trustworthiness of software layers over specific architectures
  - Development and coordination with relevant software distribution to provide ports of the latter to the architectures targeted by the virtual environments.

- Open source interfaces that permit the deployment of tested stacks on the outcomes of European processor initiatives. Proposals should address at least one of these points:
  - Open hardware interfaces able to integrate components in processor architectures prepared for deploying cloud applications. The focus should be in optimizing and expanding the interface possibilities of the aforementioned components vis-à-vis existing hardware computing standards.
  - Software to provide the basic initialization of cloud servers based on processor components and the runtime interfaces for operating systems and programs.

European Innovation Leadership in Electronics

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-38: International cooperation in semiconductors (CSA)

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

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

- Advise the EC on joint actions with leading semiconductor countries (e.g. Japan, South Korea, Taiwan) in support of EU policies.
- Support the Commission to define and implement measures aiming at strengthening the position of Europe's industry in the global semiconductor value chain.
- Provide factual elements (e.g. state-of-the-art, emerging technologies…) for the EC assessment on areas of cooperation

Scope: Within the context of semiconductor and semiconductor-based photonics (e.g. Silicon photonics), the CSA will support the EC on the following activities:

- Preparation of a regional mapping of industrial strengths and gaps and their expected evolution
- Identification of emerging opportunities (e.g. technologies, approaches) for cooperation with other regions
- Definition of research areas in which international cooperation would result in tangible benefits for Europe
- Promotion and contribution to standardisation activities
- Organisation of joint events contributing to the above outcomes
- Promotion of mobility of researchers in specific topics (in cooperation with other support schemes)
- Preparation of a comparative analysis of modalities for cooperation and their applicability

The Commission will actively engage with Member States ensuring that their interests and views are taken into account fully.

European Innovation Leadership in Photonics

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-03: Advanced multi-sensing systems (Photonics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 48.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 5 by the end of the project – see General Annex B.

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

- Next generation multi-sensing photonic and electronic systems with increased integration of new functionalities, decreased size and cost-effective manufacturing.
- Supporting a European open strategic autonomy in key integration and packaging technologies and related manufacturing value chains.
- Sensing devices and components 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.
- Reinforcing European industrial leadership in high performance multi-sensing systems and components for sectors such as healthcare and well-being, environmental monitoring and protection, transport and automated driving, manufacturing, aerospace and security.

Scope: The proposals will enable breakthroughs in sensor systems by combining component development, system integration, packaging and cost-effective manufacturing processes. They should propose innovative approaches capable of acquiring, processing and interpreting vast amounts of sensory input data, where relevant, while reducing significantly overall energy consumption.

Whenever justified, a modular approach with interchangeable components operating in a platform environment should be favoured. The sensing functionality should build on technologies related to light and include integration with microelectronics or micro-nano-mechanical, micro-fluidic, magnetic, radio frequency or bio-chemical technologies where appropriate.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

This topic implements the co-programmed European Partnership for Photonics.

6G and foundational connectivity technologies

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-01-30: European Enabling technologies for Beyond 5G/6G RAN disaggregated architectures (RIA)

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

Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

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

- Availability of European capabilities for enabling hardware, computing, signal processing technologies for beyond 5G (B5G) and future 6G infrastructures in the context of disaggregated, virtualized networks, for both small cell networks and cloud-based macro RANs.
- Availability of European capabilities for B5G/6G computing based on new computing architectures for Base station including accelerators (e.g. FPGA's) capable of supporting even the most demanding 5G/6G processes in cloud servers and white box base stations or routers.

Scope:

- B5G and 6G Base station computing and processing capabilities enabling the most demanding high performance, real time Radio Access Network (RAN) functions such as dynamic spectrum sharing in the context of disaggregated RAN architectures. It includes acceleration capabilities for real time virtualisation engines.
- Future RAN computing architectures and technology implementable in cloud or distributed computing platforms whilst addressing the current Open RAN limitation, notably energy efficiency and security. It supports 5G spectrum implementation above C band and future 6G spectrum capabilities as well as massive MIMO implementations. ASIC implementation benchmark may be taken as a target for performance validations.
- Open computing platform supporting future RAN disaggregation and virtualization and enabling an open multivendor architecture, on which large numbers of European equipment vendors may innovate. Openness also enables intelligent RAN real time management, notably through Machine Learning processes enabling key performance optimisation, in particular spectrum sharing.

The proposal should include a clear European strategy for the emergence of a European capability in this communication-computing domain where Europe is today not at the forefront. The strategy is expected to leverage new opportunities offered by the trend towards network disaggregation and cloud implementation of functions. It offers a clear path towards exploitation and industrial commitment.

For this activity, a clear complementarity strategy with relevant actions like Key Digital Technologies Joint Undertaking, Smart Networks Services Joint Undertaking, the Important Project of Common European Interest (IPCEI) on micro electronics and communication is sought.

It is considered that participation of key European industrial players and RTO's from the communication domain, the micro electronic domain, as well as key SME's in these domains are needed.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DIGITAL-EMERGING-01-39: Ultra low energy and secure networks (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 13.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 6 by the end of the project – see General Annex B.

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

The work will contribute to i) a reinforced European leadership in connectivity, devices and service infrastructure, with European capabilities in shaping future connectivity standards, ii) a digital and green transitions towards low carbon footprint of connectivity platforms iii) enabling most demanding industrial use cases requiring very high grade of QoS and performances (real-time sub-millisecond latency and secure applications)

The research covers enabling technologies for the long term objective of i) ultra low energy networks and corresponding EU industrial capability for end-to-end all-optical communications with no electro-optical conversion ii) ultra high security over fibre nets (e.g quantum grade beyond today's range limitation). Complementary protocol level work may be considered to alleviate IP limitations, making networks deterministic, drastically reducing energy needs whilst increasing performances in terms of security, control by applications of differentiated features, and implementability as "Network on a Chip".

Scope: Multidisciplinary projects with high scientific breakthrough potential towards lifting key technological roadblocks are expected. Work covers the following areas:

- Technology for ultra high energy efficiency and capacity, with optical functions replacing more power-hungry electronics, towards the realisation of end-to-end all-optical networks. It aims at replacing electro-optical interfaces and their management by

lower power optical interfaces and targets the extension to new wavelength bands to reach rates of 10 Terabit/s for optoelectronic Interfaces and over 1 Petabit/s for optical fibre systems.

- Technology for Ultra high security and reliability, targeting improvements needed to reach end-to-end very high grade of security levels. Post-quantum replacements of current algorithms or provable and long-term secure data transmission of highly sensitive information is in scope, as well as novel. research directions like physical layer security for optical networks..

Use cases may target highly integrated Radio-optical networks, coping with a multiplicity of scenarios requiring different functional splits between different network parts, enabling optimal low cost operations of integrated fronthaul-backhaul and deterministic network behaviour for specific applications requiring ultra low latency.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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 (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 17.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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 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. Proposal results are expected to contribute to several 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. Make use of open access database and using standards for data documentation (e.g. CHADA).
- 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.

Call - Digital and emerging technologies for competitiveness and fit for the green deal

HORIZON-CL4-2022-DIGITAL-EMERGING-02

Conditions for the Call

Indicative budget(s)[183]

Topics	Type of Action	Budgets (EUR million) 2022	Expected EU contribution per project (EUR million)[184]	Number of projects expected to be funded
Opening: 16 Jun 2022 Deadline(s): 16 Nov 2022				
HORIZON-CL4-2022-DIGITAL-EMERGING-02-05	IA	19.00	3.00 to 5.00	5
HORIZON-CL4-2022-DIGITAL-EMERGING-02-06	RIA	28.50	Around 4.00	7
HORIZON-CL4-2022-DIGITAL-EMERGING-02-07	IA	36.00	Around 6.00	6
HORIZON-CL4-2022-DIGITAL-EMERGING-02-17	RIA	16.50	Around 16.50	1
HORIZON-CL4-2022-DIGITAL-EMERGING-02-18	RIA	9.00	Around 9.00	1
HORIZON-CL4-2022-DIGITAL-EMERGING-02-19	RIA	6.00	Around 6.00	1
HORIZON-CL4-2022-DIGITAL-EMERGING-02-20	IA	9.00	Around 9.00	1
HORIZON-CL4-2022-DIGITAL-EMERGING-02-22	CSA	3.00	Around 3.00	1

183 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.

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

Overall indicative budget		127.00		

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

Innovation in AI, Data and Robotics

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-02-05: AI, Data and Robotics for Industry optimisation (including production and services) (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 19.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio coverage, grants will be awarded to applications not only in order of ranking but also to at least the 2 highest ranked for each type of industry (i.e. production or service), provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties.The support to third parties can only be provided in the form of grants.As third parties' grants may include robotics components, requiring high equipment investment and/or important effort to integrate in a use-case to address the sectorial challenges, the maximum amount to be granted to each third party is EUR 200 000.

Expected Outcome: Proposal results are expected to contribute to at least one of the following expected outcomes:

- Advancing AI, data and robotics, and automation for the optimisation of production and services value-chains, optimisation of products, services, processes, to increase competitiveness, improve working conditions, and environmental sustainability, and supporting the European Economy using AI, data and robotics technologies.
- AI or learning systems (including, but not limited to self-learning, continuous and transfer learning, self-configuring systems) 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: Proposals are expected to integrate and optimise AI, data and robotics solutions in order to demonstrate, by addressing use-cases scenarios in actual or highly realistic operating environments, how they optimise production and service use cases.

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,

FAIR[185] 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 technological 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 production[186] to services) can substantially benefit from optimising AI, data and/or robotics to maximise such benefits. Proposals are expecting to focus on specific use-cases to demonstrate such benefits, cross-sector use-cases are encouraged. 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 the enabling of 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 (including capturing and elicitation), 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 actual or highly realistic operating demonstrators at TRL6-7.

Proposals should clearly identify the sector it will focus on (either production or services).

Two types of proposals are expected:

1. Focused projects (EU contribution around EUR 3.00 milliom), involving the user industry and technology provider(s),

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185 FAIR data are data which meet principles of findability, accessibility, interoperability, and reusability

186 Note that in the case of manufacturing, duplication with destination 1 topics are excluded. Therefore, proposals in this topic should demonstrate that they address topics different from those addressed in destination 1 topics.

2. Larger projects (EU contribution around EUR 5.00 million), 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 all types of companies, but only SMEs and Start-ups [187] will receive financial support to third parties, with a maximum of EUR 200 000 per third party[188] and 70% funding (100% for start-ups). At least 40% of the requested amount should be dedicated to financial support to third parties. 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. Maximum one type of third party project will be funded per focused area (either production or services).

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, must receive support from business experts, provided by the action, to further develop their business and develop their market reach, and maximise their business opportunities.

When possible, proposals should build on and reuse public results from relevant previous funded actions, including public results developed in Member States and Associated Countries. 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 platform[189], Digital Industrial Platform for Robotics[190], data platforms[191] 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.

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187 *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 EUR €50 000 early stage private sector investment or has demonstrable sales growth over 50% pa – they will receive 100% financial support to third parties while other SMEs would receive 70% financial support. 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.*

188 Maximum amount per third party, received from a given action, over its entire duration

189 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

190 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

191 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 UN SDGs and the Green Deal (e.g.: sharing private data for the public good, B2G in addition to B2B; G2B data sharing may be identified, in view of helping businesses to increase sustainability and competitiveness).

Proposals 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.

All proposals are expected to allocate tasks to cohesion activities with the co-programmed partnership on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other European partnerships are encouraged.

Tomorrow's deployable Robots: efficient, robust, safe, adaptive and trusted

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-DIGITAL-EMERGING-02-06: Pushing the limit of physical intelligence and performance (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 28.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposal results are expected to contribute to at least one of 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, for example by using multi-modal sensing).

- Robots with greatly improved intrinsically safe and efficient human-centric human-robot and robot-environment/objects 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: Proposals are expected to focus on technology and systems that significantly extend the physical capability of robots beyond the state of the art. Proposals should:

- 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 periods 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 (e.g.: collaborative, modular and distributed, hyper redundant, highly reconfigurable, soft or miniaturised robotics) 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, integrated and embedded systems for AI at the edge, 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, sympathetic automated adaptation, 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, proposals 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 4-5 by the end of the project.

When possible, 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 platform[192], Digital Industrial Platform for Robotics[193], data platforms[194] 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.

All proposals are expected to allocate tasks to cohesion activities with the co-programmed partnership on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other European partnerships are encouraged.

HORIZON-CL4-2022-DIGITAL-EMERGING-02-07: Increased robotics capabilities demonstrated in key sectors (AI, Data and Robotics Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

192 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

193 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

194 E.g.: https://www.big-data-europe.eu/

Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties.The support to third parties can only be provided in the form of grants.As third parties' grants may include robotics components, requiring high equipment investment and/or important effort to integrate in a use-case to address the sectorial challenges, the maximum amount to be granted to each third party is EUR 200 000.

Expected Outcome: Proposals results are expected to contribute to at least one of the following expected outcome:

- Demonstrators able to show the added value of robotics and their performances in addressing challenges in major application sectors, or in dangerous, dull, dirty tasks or those strenuous for humans or in extreme environments.
- Systems able to demonstrate beyond human performance in complex tasks, with high impact in key sectors, that show extended levels of adaptation and flexibility.
- Systems able to show high levels of reactivity and responsiveness and intelligibility when performing human-robot and robot-robot interactions in major application sectors.

Scope: Proposals are expected to focus on application oriented use cases that enhance specific sectors in achieving significant improvements functional and economic performance.

Proposals will integrate novel robotics technologies into solutions that are capable of autonomously taking over dangerous, dull and dirty jobs, or that are capable of achieving tasks beyond human capabilities, in a range of innovative applications in key sectors or that are capable of 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[195] 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 proposals, expected to exploit the latest robotics advances and demonstrate at TRL6-7 use-case scenarios considering end-user needs and expectations, in highly realistic operating 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.

[195] Social Sciences and Humanities

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 application sector, from service to production, to domestic use. For this, an interdisciplinary approach involving both technical and SSH[196], 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[197] 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 requested amount for FSTP to support SMEs or Start-ups in the development or enhancement of demonstrators, with a maximum of EUR 200 000 per third party[198], 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 prioritise high impact sectors and use-cases where the technology can demonstrate maximum added value.

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196 Social Sciences and Humanities

197 https://en.wikipedia.org/wiki/Intersectionality - intersectional aspects could cover gender, age, social level, education, ethnic origin, etc.

198 Maximum amount per third party, received from a given Action, over its entire duration

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 and/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.

When possible, 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 platform[199], Digital Industrial Platform for Robotics[200], data platforms[201] 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 destinations 1, 3, 4 and 6, but also in other destinations and clusters, and share or exploit results with relevant funded actions where appropriate.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02. Where relevant, synergies with other PPPs are encouraged.

Graphene: Europe in the lead

Proposals are invited against the following topic(s):

Proposals are invited against the following topic(s):

199 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

200 https://robmosys.eu/newsrobmosys-rosin-towards-an-eu-digital-industrial-platform-for-robotics/

201 E.g.: https://www.big-data-europe.eu/

HORIZON-CL4-2022-DIGITAL-EMERGING-02-17: New generation of advanced electronic and photonic 2D materials-based devices, systems and sensors (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 16.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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, 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 technologies 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 imaging 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 integrate the value chain and incorporate the relevant manufacturing technologies needed to bring the developed devices towards the market and indicate how they work with the newly established Graphene Flagship 2D-Experimental Pilot Line (2D-EPL)[202].

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.

[202] https://graphene-flagship.eu/innovation/pilot-line/

Proposals should include activities aiming at facilitating future exploitation of results.

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5).

Proposals should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DIGITAL-EMERGING-02-18: 2D materials-based devices and systems for energy storage and/or harvesting (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Proposal results 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.

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 integrate the value chain and incorporate the relevant manufacturing technologies needed to bring the developed devices towards the market.

Proposals should include activities aiming at facilitating future exploitation of results.

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5).

The proposal should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DIGITAL-EMERGING-02-19: 2D materials-based devices and systems for biomedical applications (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 and achieve TRL 5 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 continuous health monitoring and 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 biochemical or bioelectronic diagnostics 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). The safety aspects of the proposed technologies should be given proper consideration.

Proposals should include activities aiming at facilitating future exploitation of results.

Proposals should aim at demonstrating by the end of the project fully functional prototypes operating in relevant environment conditions (TRL 5).

The proposal should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

HORIZON-CL4-2022-DIGITAL-EMERGING-02-20: 2D-material-based composites, coatings and foams (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

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

- new multifunctional recyclable materials enabling solutions to environmental challenges.

Scope: Proposals should address 2D materials (2DM) composites, aero-gels and foams that can bring the full nanoscopic functionality of 2DM from nano- and microscale into the

macroscopic world. They should target in particular the development of 2D materials and technologies mainly addressing environmental issues including e.g. energy consumption reduction in transport, oil spill removal from water, water purification with low energy consumption and improved water desalination. They should also target the development of next generation, lightweight, recyclable composites and coatings endowed with key functionalities like e.g., high temperature performance, structural health monitoring, and as enablers for, e.g., structural batteries or hydrogen storage. They should also address Metal-2DM composites enabling ultralow friction surfaces, reducing energy loss in sliding mechanical and electrical parts and the development of 2DM foams enabling hydrogen economy through catalytic hydrogen generation and storage. Proposals should also integrate the value chain and incorporate the relevant manufacturing technologies necessary to bring the developed devices towards the market.

Proposals must implement from the very beginning life cycle assessment (LCA) and end-of-life (EOL) materials management to fully capture the advantage and develop greener materials and processes.

Proposals should include activities aiming at facilitating future exploitation of results.

Proposals should aim at demonstrating by the end of the project fully functional material systems and prototype applications operating in relevant environment conditions (TRL 6-7).

The proposal should also cover the contribution to the governance and overall coordination of the Graphene Flagship initiative.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-DIGITAL-EMERGING-02-22: Supporting the coordination of the Graphene Flagship projects (CSA)

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

Expected Outcome: Proposal 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 projects of the Graphene Flagship initiative 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 standardisation activities, creating new education and training curricula, promoting innovation, developing research and innovation roadmap activities, liaising with and supporting the coordination 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).

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

DESTINATION – 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 SGDGs). 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:

- 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 B, **'Restoring Europe's ecosystems and biodiversity, and managing sustainably natural resources** to ensure food security and a clean and healthy environment.

- 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 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 EU capacity to access to space

3 Evolution of Space and ground infrastructures for Galileo/EGNOS

4 Evolution of services: 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

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 the Strategic Research and Innovation Agenda, headings 3), 4), 5), and 6) will be supporting the Space Programme components as well as the emerging quantum 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 component infrastructures, services and applications (Heading 3) and with R&I to investigate new future services (Heading 4) or to develop innovative space capabilities such as SSA, GOVSATCOM and Quantum (Heading 6). This autonomy would however not be complete if we did not have the capacity to access space, to launch these infrastructures (Heading 2) and to 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 and entrepreneurship eco-systems in the EU (Headings 5 and Heading 7). A description of the headings objectives and targeted achievements is provided below.

<u>Foster competitiveness of space systems</u>

The European space sector and space economy need 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 the development of new competitive technologies for space and ground systems, such as very high throughput and flexible satellites, very high-resolution sensors, radiation-hardened electronics, on-board and ground Artificial Intelligence (AI), optical communication and quantum technologies, as well as advanced 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 in-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 further developed to bring breakthrough innovation to the space sector, while at the same time advancing 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 market for launch services, which is characterised by an increasing number of competitors, secondly, the emerging opportunities in space transportation that have not been 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 launchers, re-entry vehicles and modern and flexible test and launch facilities. Both will require urgent activities to enable operational capacities by at the latest 2030.

Disruptive technologies, methodologies and concepts should be developed to bring breakthrough innovation to the launcher systems sector as well as to contribute to cost reduction and contribute to the preparation of a 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, EU needs sustained investments in R&D for innovative mission concepts, technology and systems. These will ensure the continuity of the EGNSS service, minimise the risks for technology inclusion in the infrastructure, thanks to anticipated development and testing including in-orbit, protect better this infrastructure against modern threats (notably cyber, jamming/spoofing, natural hazards), and increase the strategic autonomy in key technologies. Overall, they will maintain the EU´s leadership position in the Global Navigation Satellite Systems.

Evolution of services: 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, green house gas 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 and clean energy, border management, preserving 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 new services and capabilities to better serve 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.). Europe should extend Galileo services to various societal challenges and offer it as a complementary service to emerging markets like 5G, CCAM and AI.

Development of applications for Galileo, EGNOS and Copernicus

EGNSS and Copernicus capacities are unique and world-class and should be fully utilised 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 markets with a long lead-time (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, civil security, migration and agriculture. They and can bring, with 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 the creation of a wealth of new and innovative applications and

services. The use of Copernicus and Galileo/EGNOS for the EOSC and DestinE initiatives should equally be taken into account and promoted.

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 centres (including critical technological elements for the realisation 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 environment of worldwide hybrid threats (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 the 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 overcoming 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 validating. The availability of adequate ground segment infrastructure for testing and validating the quantum space mission needs to be ensured too. 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.

CASSINI will provide support to business and innovation-friendly ecosystems, including the strengthening business skills in the space market segments and digital services based on space data. The objective is to make start-ups and scale-ups investment-ready and able to secure venture capital funding. Synergies with the InvestEU programme and the Space programme will be established.

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 perform R&I for the Space Programme.

These targeted and strategic actions will include the development of critical technologies for EU non-dependence, the establishment of regular and cost-effective flight opportunities for In-Orbit Demonstration/In-Orbit Validation (IOD/IOV), space science activities, as well as outreach, education and international cooperation activities.

Limiting participation in certain actions to Member States (and certain candidate associated countries to Horizon Europe)

The Space research part of the Horizon Europe Programme is by default open to the world, promoting international cooperation to drive scientific excellence.

However, an important aspect of the Space Programme consists in ensuring security and strengthening strategic autonomy across key technologies and value chains, taking advantage of the possibilities that space offers for the security of the Union and its Member States. This objective requires special rules in specific cases to set the requisite eligibility and participation conditions to ensure the protection of the integrity, security and resilience of the Union and its Member States. Hence, on an exceptional basis and duly justified, the work programme may foresee a limited participation to entities from selected countries. Such exceptional circumstances would relate to prevalent considerations to safeguard the Union's strategic assets, interests, autonomy or security. Possibilities for such limitations are framed by Article 22(5)and by Annex IV(11a) of the Horizon Europe Regulation. Out of 45 actions, 30 remain fully open while 15 are proposed for limited participation

For six space actions, the restrictions to only Member States are justified under Annex IV of the Horizon Europe Regulation which foresees that, where appropriate the eligibility criteria of the Space Programme Regulation shall apply for the Horizon Europe space research topics and actions. In the current work programme this includes SST and GOVSATCOM which relate to sensitive Union space infrastructure.

Nine space actions are open to Member States, Norway and Iceland under Protocol 31 of the EEA Agreement and the United Kingdom. These nine actions include Copernicus Security R&D and actions involving technologies critical to strategic autonomy/dual-use.

The eligibility to participate in such actions is limited to legal entities established in the EU, Norway, Iceland and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

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

Call	Budgets (EUR million)		Deadline(s)
	2021	2022	
HORIZON-CL4-2021-SPACE-01	136.22		16 Feb 2022
HORIZON-CL4-2022-SPACE-01		85.70	16 Feb 2022
Overall indicative budget	136.22	85.70	

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)[203]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[204]	Number of projects expected to be funded
Opening: 02 Nov 2021 Deadline(s): 16 Feb 2022				
HORIZON-CL4-2021-SPACE-01-11	RIA	12.00 [205]	4.00 to 6.00	2
HORIZON-CL4-2021-SPACE-01-12	RIA	6.00	1.00 to 2.00	3
HORIZON-CL4-2021-SPACE-01-21	RIA	39.00 [206]	30.00 to 39.00	1
HORIZON-CL4-2021-SPACE-01-22	RIA	19.80 [207]	15.00 to 19.00	1
HORIZON-CL4-2021-SPACE-01-23	RIA	3.00 [208]	1.00 to 1.50	2
HORIZON-CL4-2021-SPACE-01-41	RIA	11.00 [209]	10.00 to 11.00	1
HORIZON-CL4-2021-SPACE-01-42	RIA	7.50 [210]	6.00 to 7.50	1
HORIZON-CL4-2021-SPACE-01-43	RIA	5.00 [211]	4.00 to 5.00	1

203 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.

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

205 Of which EUR 7.20 million from the 'NGEU' Fund Source.

206 Of which EUR 26.01 million from the 'NGEU' Fund Source.

207 Of which EUR 11.98 million from the 'NGEU' Fund Source.

208 Of which EUR 1.81 million from the 'NGEU' Fund Source.

209 Of which EUR 6.72 million from the 'NGEU' Fund Source.

210 Of which EUR 4.48 million from the 'NGEU' Fund Source.

HORIZON-CL4-2021-SPACE-01-44	RIA	5.60 [212]	Around 3.00	2
HORIZON-CL4-2021-SPACE-01-62	RIA	17.00	15.00 to 17.00	1
HORIZON-CL4-2021-SPACE-01-81	RIA	10.32 [213]	2.00 to 3.00	4
Overall indicative budget		136.22		

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

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and

211 Of which EUR 2.78 million from the 'NGEU' Fund Source.
212 Of which EUR 3.39 million from the 'NGEU' Fund Source.
213 Of which EUR 6.72 million from the 'NGEU' Fund Source.

	selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[214]

[214] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure,

Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

Expected Outcome: The expected outcomes of this topic will enable flexible end-to-end satellite communication system (including both space and ground segment) with high productivity and growing data and service requirements. Security aspects should be considered in all targeted developments. Competitiveness will be strengthened 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.
- Full inclusion and utilisation of satellite communication in 5G/6G network
- 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 quantum satellite communication capacity.
- Contribute to 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-mentioned expected outcomes are:

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facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

1) R&I on secure quantum communications through 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, protocols, development of virtual network and application functions as well as 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.

Proposal should address only one area. To ensure a balanced portfolio covering the two 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.

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 explore synergies and be complementary to already funded actions in the context of technology development at component level. In particular, the topics: Critical Space Technologies for European non-dependence (H2020 SPACE-10-TEC-2018-2020, COMPET-1-2014-2015-2016-2017), satellite communication technologies and high speed data chain (H2020 COMPET-2-2016, COMPET-3-2017, SPACE-15-TEC-2018, SPACE-29-TEC-2020). Furthermore, activities should be complementary to national activities and activities funded by the European Space Agency (ESA), while contributing to EU non-dependence.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Unless otherwise agreed with the granting authority, beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners or subcontractors are established in countries which are not eligible countries or target countries set out in the call conditions or are controlled by such countries or entities from such countries.

HORIZON-CL4-2021-SPACE-01-12: Future space ecosystems: on-orbit operations, new system concepts

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: 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.
Technology Readiness Level	Activities addressing area 1 of the call topic are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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.

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 (e.g. debris mitigation).

- 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 need to be addressed to tackle the above expected outcomes are:

1) R&I on new scalable 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. The approach should consider 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. 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 mission[215] by using pre-existing standard interfaces[216] (*plug-and-play* concept). The module design should support the integration of different pre-existing standard interfaces[113]. Further reference is given in a technical guidance document applicable to this area[217].

2) R&I on new on-orbit services concepts concentrating on a next generation of potential business cases (e.g. satellite recycling, transfer services, logistics, warehousing, etc.) contributing to a sustainable space infrastructure and in-space ecosystem development. Work should include, but not be 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 *Assembly Integration and Testing (AIT)* processes in satellite life cycle.

Proposals should explore relevant and promising solutions derived in Horizon 2020 activities, especially project results from the Strategic Research Clusters *Space Robotics Technologies*[218] and *Electric Propulsion*[219].

A proposal may address more than one area but must indicate the main area addressed, and is expected to promote cooperation between different actors (industry, SMEs and research

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215 To be developed under topic HORIZON-CL4-2022-SPACE-01-11

216 Multi-functional interface for OOS applications providing at least transfer of mechanical loads, power and data, (e.g. HOTDOCK, iSSI or SIROM)

217 Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

218 *www.h2020-peraspera.eu*

219 *www.epic-src.eu*

institutions) and consider opportunities to quickly turn technological innovation into commercial space usage.

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 project that is the highest ranked within each area, provided that the applications attain all thresholds.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Reinforce EU capacity to access and use space

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-21: Reusability for European strategic space launchers - technologies and operation maturation including flight test demonstration

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 30.00 and 39.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 39.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States,

	Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[220]
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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 (with respect to A6/VegaC cost/price 2021 economic conditions), 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).

220 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

- Matured technologies up to TRL5/6, integration of system tests vehicle, on-ground and low altitude system tests by 2023 and contribution to the preparation of suborbital system tests potentially in 2025.

- Cost reduction investigation and system tests.

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 tests including system, vehicle integration, ground tests, low altitude flight system tests by 2023 and contribution to the preparation up to ground based system tests of suborbital flight system tests by 2025. The execution of the suborbital tests is not part of the scope.

The developed enabling technologies and building blocks should be applicable to strategic launchers able to launch EU Space Programme components, with the objective of enabling operational capacities by 2030. The system tests vehicle should be representative of a reusable 1st stage of a strategic EU launcher. This vehicle should 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 must also support EU non-dependence objective and include the assessment of costs reduction investigations and system tests 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),

- manoeuvring control devices,

- Health Monitoring System (HMS), propellant management,

- aerodynamic devices,

- descent and landing/recovery systems, including low latency, closed loop communication systems for landing,
- on-ground servicing processes (refurbishment, check-out supported by automatic post flight analysis and repair and recertification for reused elements),
- safety critical processes before launch and after landing.

The activities should include as many as technologies possible in each area to maximise the number of matured technologies to be submitted to integrated tests at system level (all technologies together).

All the activities should 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. Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-SPACE-01-22: Low cost high thrust propulsion for European strategic space launchers - technologies maturation including ground tests

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 15.00 and 19.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 19.80 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's

	strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[221]
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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 (with respect to A6/VegaC cost/price 2021 economic conditions), for the benefit of EU

[221] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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)
- Identification of mature technologies at TRL 3-4 for cost-reduction possibilities in the current European launchers
- Matured technologies up to TRL 5-6 by 2023/24, including prototyping and on ground tests at subsystem level
- 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 should address maturation of enabling technologies, building blocks, tools and processes including maintenance/overhaul and safety, up to TRL5/6 and subsystem tests including prototyping and integrated tests at subsystems level.

The matured technologies, building blocks, tools and processes should 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 tests should be appropriate to this objective.

The proposed activities must also support EU non-dependence objective and include the assessment of costs reduction investigations and test 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, or new composite technologies
- maintenance/overhaul,

- associated fluidics,

The activities should include as many as technologies possible in each area to maximise the number of matured technologies to be submitted to integrated tests at subsystem level (all technologies together).

All the activities should 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. Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-SPACE-01-23: New space transportation solutions and services

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of

	access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[222]
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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).

[222] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

- Matured technologies up to TRL5-6 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 should contribute to the maturation up to TRL5-6 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, smart satellite deployment systems/dispensers, 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 and flexible dispenser for multi-satellites, constellations, and payloads launch solutions,
- Advanced avionics, 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, capturing and spacecraft management technologies, avionics and test-bed.

All the activities should 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. Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 11.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Enhanced quality and efficiency of the current service evolution to respond to (a) policy and/or user requirements (b) technological developments implementing the space regulation (c) complementing the challenges targeted by the Horizon Europe Mission on “Adaptation to climate change including societal transformation”

- Development of efficient and reliable new product chains, calling for new paradigms in data fusion, data processing and data visualisation essential for the service are expected to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive

- Development of new algorithms and processing chains preparing for the use of new types of space observation data (being from new Sentinels, other contributing missions or ESA Earth Explorer missions) in order to allow the development of new products or the improvement of existing products.

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 should 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 should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition the project could contribute to the objectives set by the DestinE initiative.

The project should provide a proof-of-concept (e.g. system element targeting TRL5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[223]

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[223] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-SPACE-01-42: Copernicus Atmosphere Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 7.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Enhanced quality and enhanced efficiency of the current service to respond respectively to policy and/or user requirements and to technological developments
- Development of 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 to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive through.
- Development of new algorithms and processing chains preparing for the use of new types of space observation data (being from new Sentinels, other contributing missions or ESA Earth Explorer missions) in order to allow the development of new products or the improvement of existing ones.

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 and measurements 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 should 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 should be tools and methodologies that can be readily transferred for improving aerosol representation in CAMS operational global and regional systems. The proposal shoud 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 should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition the project could contribute to the objectives set by the DestinE initiative.

The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[224]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-SPACE-01-43: Copernicus Security and Emergency Services evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph

[224] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

	above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[225]
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Enhanced quality and enhanced efficiency of the current services to respond respectively to policy and/or user requirements and to technological developments
- Significant improvement in resolution, detection capabilities, timely access to data and delivery of information according to the requirements of emergency and security applications
- Significant improvement in integration of non-space data along end-user intelligence supply chains, bringing added value at operational level (e.g. local and regional monitoring networks or field campaigns)
- Development of processing chain(s) to handle an increasing volume of satellite data, 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.

[225] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 (if applicable also in the context of social innovation) 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 and measurements, meteorological data, data from aerial platforms, social media or crowd-sourcing, as well as information generated from other sources and other Copernicus services. Whenever appropriate, the project should take advantage from Copernicus and EGNSS synergy.

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 should be modular and scalable. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could contribute to the objectives set by the DestinE initiative.

The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[226]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-SPACE-01-44: Copernicus evolution for cross-services thematic domains

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.60 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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

- Enhanced quality and enhanced efficiency of the current services to respond respectively to well identified emerging EU policy needs and/or user requirements and to technological developments
- Exploitation of the full range of Copernicus core services with a significant improvement in the coordination and integration of data and products between them
- Development of services which will support new policy(ies) and will address observational and information gaps
- Appropriate consideration of a wide range of users' needs and of potential accessibility limitations

Scope: The areas of R&I, which needs to be addressed to tackle the above expected outcomes are:

[226] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

- Development of a proof-of-concept or prototype with a Copernicus based-solution to improve the European capacity for monitoring and forecasting the Arctic accessed via a single entry point which can be easily integrated into the existing service(s)

- Development of a proof-of-concept or prototype with a Copernicus-based solution to improve the European capacity for monitoring the UN Sustainable Development Goals indicators accessed via a single entry point which can be easily integrated into the existing service(s) (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)

This approach should 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 should be modular and scalable and proposals should provide a proof-of-concept or a prototype that can be easily integrated into the service(s).

Proposals should 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 should have the objective to increase the capabilities and capacity of end users to use Copernicus data and products. The involved end-users should 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. If applicable also social innovation can play a role in this context.

Depending on the selected area(s), user communities should 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 should be considered and innovative solutions should 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 should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service.

Additionally, the transfer from research to operations should receive full attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. The software should be open licensed.

The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could contribute to the objectives set by the DestinE initiative.

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.

Applicants 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[227]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Innovative space capabilities: SSA, GOVSATCOM, Quantum

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-SPACE-01-62: Quantum technologies for space gravimetry

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 15.00 and 17.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 17.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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.

[227] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

	In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[228]
Technology Readiness Level	Activities are expected to achieve TRL5 by the end of the project – see General Annex B.

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

228 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

• 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.

Proposals must address all the above-mentioned, expected outcomes.

Scope: The scope of this topic is the development of EU technologies and components for a space quantum gravimeter or gradiometer (this may include hybrid sensors, relying both on quantum and classical technologies) and which will lead to the development of an Engineering Model and its potential qualification for a pathfinder mission.

The enhancement of the TRL up to TRL5 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 gravimetry 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 pathfinder mission based on cold atom interferometry demonstrating the gravimetric performance.

The proposals should answer the whole scope of this topic.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU	The Commission estimates that an EU contribution of between EUR

contribution per project	2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.32 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom and to International European Research Organisations. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.
Technology Readiness Level	Activities are expected to achieve TRL7 (areas 10, 13, 14A, 22D) and TRL6-7 (area 17) by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the additional exploitation obligations: For a period of up to 4 years after the end of the project, access rights to the use of products and/or processes generated by the project shall be

	given to European entities, in compliance with the signed Grant Agreement and with no legal restrictions and limitations stemming from International Traffic in Arms Regulations (ITAR), EAR99 or equivalent instruments applicable in other jurisdictions. Applicants must acknowledge and incorporate this obligation in the proposal and Annex I to the Grant Agreement.

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 programmes either in the space or non-space fields.

Scope: Research and innovation to mature critical space technologies selected from the European Commission-ESA-EDA Joint Task Force (JTF) List of Actions 2021-2023 shall be implemented in 2021 for the following technology areas.

- **[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 - Replacement solutions for 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.

Proposals should address only one area. To ensure a balanced portfolio covering the 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.

Activities should be complementary and create synergies 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. An assessment of commercial viability of the supply chain should be done. Identification of critical dependencies and, if applicable, a business plan for commercialization, including time to market indication, of the developed product and/or full range of recurring products should be included.

To achieve 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Unless otherwise agreed with the granting authority, beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners or subcontractors are established in countries which are not eligible countries or target countries set out in the call conditions.

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)[229]

Topics	Type	Budgets	Expected EU	Number

[229] 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.

	of Action	(EUR million) 2022	contribution per project (EUR million)[230]	of projects expected to be funded
Opening: 02 Nov 2021 Deadline(s): 16 Feb 2022				
HORIZON-CL4-2022-SPACE-01-11	RIA	26.00	20.00 to 26.00	1
HORIZON-CL4-2022-SPACE-01-12	IA	5.10	1.00 to 2.00	3
HORIZON-CL4-2022-SPACE-01-13	IA	8.10	2.00 to 3.00	3
HORIZON-CL4-2022-SPACE-01-21	RIA	2.00	1.00 to 2.00	1
HORIZON-CL4-2022-SPACE-01-41	RIA	10.00 [231]	8.00 to 10.00	1
HORIZON-CL4-2022-SPACE-01-42	RIA	6.00 [232]	5.00 to 6.00	1
HORIZON-CL4-2022-SPACE-01-43	RIA	5.00 [233]	4.00 to 5.00	1
HORIZON-CL4-2022-SPACE-01-62	RIA	2.00	0.50 to 1.00	2
HORIZON-CL4-2022-SPACE-01-72	CSA	3.00	2.00 to 3.00	1
HORIZON-CL4-2022-SPACE-01-81	RIA	10.50 [234]	2.00 to 3.00	4
HORIZON-CL4-2022-SPACE-01-82	RIA	8.00	1.00 to 1.50	6
Overall indicative budget		85.70		

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

230 Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
231 Of which EUR 8.39 million from the 'NGEU' Fund Source.
232 Of which EUR 5.02 million from the 'NGEU' Fund Source.
233 Of which EUR 4.15 million from the 'NGEU' Fund Source.
234 Of which EUR 10.47 million from the 'NGEU' Fund Source.

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

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 orbital demonstration mission

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 20.00 and 26.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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.
Technology Readiness Level	Activities are expected to achieve technology maturation up to TRL6 by the end of the project – see General Annex B.

Expected Outcome: The expected outcomes of this topic is to prepare a European pioneering, high-impact but low-cost orbital demonstration mission for On-Orbit Servicing (OOS) in

2025-2026 period that will demonstrate and showcase European know-how, support market generation, open new business opportunities, foster international cooperation and 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-C mission study[235] and target-oriented technology maturation (TRL 6) to prepare a low cost orbital demonstration mission integrating robotic and autonomy technologies and technical building blocks with high-impact on future commercial services 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 with a functional upgrade later in Phase 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 interface[236] (*plug-and-play* concept).

R&I activities related to technology maturation in the area of GNC, autonomous localization and termination, modern TM/TC data handling, low-cost and modular avionics, automated rendezvous and capturing technologies as well as avionics and test-beds are also addressed in topic HORIZON-CL4-2021-SPACE-01-23.

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 guidelines[237] should be applied to and enhanced by the orbital demonstration mission.

Further reference is given in a technical guidance document[238]. Technical documents of the previous studies in the H2020 Strategic Research Cluster *Space Robotics Technologies*[239] are available on the PERASPERA website.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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235 according to ECSS-M-ST-10C

236 Multi-functional interface for OOS applications providing at least transfer of mechanical loads, power and data (e.g. HOTDOCK, iSSI or SIROM)

237 *www.h2020-peraspera.eu*

238 Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

239 *www.h2020-peraspera.eu*

HORIZON-CL4-2022-SPACE-01-12: Technologies and generic building blocks for Electrical Propulsion

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.10 million.
Type of Action	Innovation Actions
Eligibility conditions	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.
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

Expected Outcome: Future applications will require Electric Propulsion products. However, since the exact evolution of space infrastructure and markets cannot be predicted, the development of technology building blocks is an adequate approach to better react and to adapt to needs.

Therefore, this topic aims at increasing the effort for maturing technologies and generic building blocks towards both incremental and disruptive technologies for Electric Propulsion systems products up to TRL 5/6 for thruster components, electric power architecture and products, as well as fluidic management systems and components. Furthermore, the topic addresses next generation industrial manufacturing processes and support to activities intending to allow in orbit demonstration/validation (IOD/IOV).

Projects are expected to contribute to the following outcomes:

- Strengthen, in the medium term, the European capacity to compete worldwide in electric propulsion satellites and missions
- Technologies matured to at least TRL 5/6 at component level
- Matured industrialisation aspects for high TRL solutions
- Contribution to the preparation of the evolution of electric propulsion systems including Hall Effect Thrusters (HET), Gridded Ion Engines (GIE), High Efficiency Multistage

Plasma Thrusters (HEMPT), in four power classes (very low up to 0,3 kW; low: 0,3-1,5 kW; medium 3- 7 kW; high 12-20 kW).

Scope: The areas of R&I, which need to be addressed to tackle the above-expected outcomes, are:

1) R&I on generic building blocks technologies for thruster components (anode configuration, magnetic nozzle, cathode, materials, alternative propellants, new manufacturing processes).

2) R&I on electrical power architecture and related components (Power Processing Unit, direct drive, etc.).

3) R&I on fluidic management system and related components.

Proposal may address one or several of the above mentioned areas and should consider aspects of manufacturing, standardisation, diagnostics, characterisation in order to serve next generation industrial manufacturing processes.

The scope of activities includes, where appropriate, the preparation of IOD/IOV demonstration(s).

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.

Further reference is given in a technical guidance document[240]. Technical documents of the previous studies in the H2020 Strategic Research Cluster *Electric Propulsion*[241] are available on the EPIC website.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-SPACE-01-13: End-to-end Earth observation systems and associated services

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.10 million.
Type of Action	Innovation Actions

[240] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

[241] *www.epic-src.eu*

Eligibility conditions	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.
Technology Readiness Level	Activities are expected to achieve TRL6 by the end of the project – see General Annex B.

Expected Outcome: The expected outcomes of this topic will enable flexible satellite Earth-observation end-to-end systems, including the ground segment subsystem with explicit aspects of ground control centres and operations, as a strong subject of the "new space" and a very dynamic market environment with high potential. Competitiveness will be strengthened by providing growing capacity, 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:

- Maintain the worldwide leadership for Earth Observation system by 2028 addressing (1) reactive very high resolution and (2) smart persistent (up to video) Earth observation.
- Short to medium term disruptive development and maturation of key technologies (up to TRL6) for high performance Earth-observation.
- Contribute to EU non-dependence for the development of Earth-observation technologies.
- Ground segment that meets the increased demand for data rates and volumes, satellite constellations, higher frequencies, multi-mission data with increased needs for data fusion, AI techniques and infrastructure security.
- A European demonstrator mission by 2026-27, showcasing EU technologies in preparation of an IOD/V:
    - Reduction by 50% the cost of sub-metric missions by 2027
    - Image acquisition at below 50cm resolution anywhere in less than 1 hour from the user request
    - Drastic time reduction between user request and image availability
    - Preparing the ground segment subsystem for future modular, flexible and intelligent satellites.

Scope: The areas of R&I, which needs to be addressed to tackle the above-expected outcomes are:

1) R&I on end-to-end systems, in particular addressing aspects such as enhanced end-to-end system autonomy or accelerating AIT processes for small/medium series production.

2) R&I on observation payload, in particular addressing technologies and concepts for detectors and sensors, radar and optical (including IR/night capabilities) leading to e.g. very high resolution at lower price and persistent observation up to video, as well as satellite and platforms with on-board autonomy for data storage and image processing for end-to-end performance.

3) R&I on scalable, automatable, flexible and resilient multi-mission solutions for ground segment able to be adapted and operate efficiently in complex scenarios, which are necessary for enhanced autonomy for fleet management and flexible mission planning. Proposals should consider enabling technologies and solutions aiming at exploiting the potential synergies between the Earth observation, satellite communication and on-orbit services domains.

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.

Proposals are expected to promote cooperation between different actors (industry, SMEs and research institutions) and consider opportunities to quickly turn technological innovation into commercial use in space.

Proposals under this topic should explore synergies and be complementary to already funded actions in the context of technology development at component level. In particular, the topics: Critical Space Technologies for European non-dependence (H2020 SPACE-10-TEC-2018-2020, H2020 COMPET-1-2014-2015-2016-2017); Earth observation technologies (H2020 COMPET-2-2017, H2020 EO-3-2015, H2020 SPACE-14-TEC-2018-2019). Furthermore, activities must be complementary to national activities and activities funded by ESA, while contributing to EU non-dependence.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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 European access to space ground facilities

Specific conditions

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic. For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the

	action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[242]
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.

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 (with respect to A6/VegaC cost/price 2021 economic conditions), 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 standardised 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 access to space 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. In addition, EU access to space ground facilities needs to become interoperable allowing to decrease the launch service costs.

242 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
(a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
(b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
(c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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:

    - 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

    - 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 :

    - modern data handling, data processing, diagnostic techniques

    - eco-friendly technologies,

    - automation and innovative controls,

    - mobile telemetry systems, mobile payload preparation facilities,

    - vacuum simulation test facilities,

    - security and safety

All the activities should 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. Proposals should provide all IPR dependencies and dependencies with other on-going activities, and detail the implementation, the reporting and the organisational as well as steering measures that will be taken to ensure that the proposed activities can be implemented and can achieve all the expected outcomes within the project schedule and budget.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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: Copernicus

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-41: Copernicus Marine Environment Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome:

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

- Enhanced quality and efficiency of the current service to respond to (a) policy and/or user requirements (b) technological developments implementing the space regulation (c) complementing the challenges targeted by the Horizon Europe Mission on “Healthy oceans, seas, coastal and inland waters” and can also contribute to the initiative United Nations Decade of Ocean Science for Sustainable Development.

- Development of efficient and reliable new products chains, calling for new paradigms in data fusion, data processing and data visualisation essential for the service to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive.

- Development of new algorithms and processing chains preparing the use of the new types of space observation data (being from new Sentinels or other contributing missions) in order to allow development of new products or the improvement of existing products.

Scope: The main scope of this R&I is the development of new and innovative models for marine ecosystems monitoring and related biogeochemistry. These models will be used to prepare Copernicus-based solutions for different policies areas and for the challenges related to biodiversity conservation. 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 should 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 should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could contribute to the objectives set by the DestinE initiative and by the Marine Digital twin under development following the H2020 Green Deal call.

New technological tools should be considered and innovative solutions should 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 should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the

results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[243]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-SPACE-01-42: Copernicus Anthropogenic CO_2 Emissions Monitoring & Verification Support (MVS) capacity

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

Expected Outcome: The expected outcome is the continuation of the set up of the new Copernicus element for the monitoring of anthropogenic CO2 emissions that includes:

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 (CO_2, NO_2, CO, CH_4) in support of CO_2 fossil fuel emission estimation
- New and innovative methods to better use of auxiliary observations such as ^{14}C (radiocarbon), SIF (Solar Induced Fluorescence), and APO (Atmospheric Potential Oxygen) to separate anthropogenic CO_2 emissions from the natural variability of CO_2

[243] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

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 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 Force[244] .

The activities should support the further development of the foreseen European operational monitoring support capacity for fossil fuel CO_2 emissions. These activities should complement or follow-up on the activities within the H2020-funded CO2 Human Emissions (CHE)[245] project and the Prototype system for a Copernicus CO_2 service (CoCO2)[246] project.

The activities, as described in the Guidance document, should 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 CO_2 monitoring Task Force.

More generally, this action should 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 should 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 should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL 5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could potentially contribute to the objectives set by the DestinE initiative.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the

244 https://www.copernicus.eu/en/news/news/new-co2-green-report-2019-published
245 https://www.che-project.eu/
246 https://www.coco2-project.eu

Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[247]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-SPACE-01-43: Copernicus Land Monitoring Service evolution

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Enhanced quality and efficiency of the current service to respond respectively to policy and/or user requirements and to technological developments.
- Development of efficient and reliable new products chains, calling for new paradigms in data fusion, data processing and data visualisation essential for the service to handle more high-volume satellite data sets and product sets. The baseline is to preserve continuity of what has been achieved while keeping the service modern and attractive.

Development of new algorithms and processing chains preparing for the use of the new types of space observation data (being from new Sentinels or other contributing missions) in order to allow development of new products or the improvement of existing products.

[247] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

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 Natura 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 should 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 should be modular and scalable. The project should provide a proof-of-concept (e.g. system element targeting TRL5-6) at least demonstrating the feasibility of the integration in the existing core service. The activities of the project should also contribute to the objectives set by the Group on Earth Observation and outcomes and relevant results of the project should be promoted also at international level through the Global Earth Observation System of Systems (GEOSS). In addition, the project could potentially contribute to the objectives set by the DestinE initiative.

Additionally, the transfer of research results to possible operations should receive active attention during the course of the project to strengthen the readiness for an operational deployment in the future. Appropriate interaction with the relevant Entrusted Entity of the Copernicus services, the conditions for making available, for re-using and exploiting the results (including IPR) by the said entities must be addressed during the project implementation. Software should be open licensed.

Applicants 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[248]

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In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Innovative space capabilities: SSA, GOVSATCOM, Quantum

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-SPACE-01-62: Space Weather

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 0.50 and 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL3-4 by the end of the project – see General Annex B.

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

[248] Published on the EU funding and tenders portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal)

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 should address application domains that may include space as well as terrestrial infrastructure. Proposals should include architectural concepts of possible European space weather services in relation to the application domains addressed and they should 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.
- Develop concepts to provide space weather data, forecasts and warnings with criteria on (timely) availability, harmonized (data) standards and quality control similar to the best-practices of meteorological services (as e.g. documented by the World Meteorological Organisation WMO).
- Improve scientific understanding of the origin and evolution of space weather phenomena.
- Improving SWE restitution and prediction capabilities using artificial intelligence / deep learning techniques.
- Develop new services for both scientific purposes and terrestrial infrastructure monitoring.
- Acceleration innovation of enabling technologies (maturing, prototyping, on ground tests including exploratory ground based instrumentations research)
- Identified and matured concepts up to TRL 3-4

Scope:

- New modelling including ab-initio simulations to understand fundamental Sun-Earth physical mechanisms and their sensitivity to parameter change for improved forecasting skills, 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 should 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.
- Validate and harmonize the currently available data from existing services and identify gaps in data and model availability.

- 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.
- On ground demonstration tests
- Ground instruments: densification of ground instrument networks and development/improvement of new instrument concepts
- Complementary and coherent activities with existing space weather services with a significant involvement of European and national scientific institutions and stakeholders.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: 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 of 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 EU-27 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 evidence and encompass EU-27 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. It should not be limited to technical, scientific, engineering disciplines but also includes the essential soft skills needed, such as the 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 will 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 a better match between the needs and the offer in the coming years. For this, a benchmarking of the career opportunities for space-oriented graduates coming from different universities across the 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 EU-27 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 studies 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.

- 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 studies.

- 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.50 million.

Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: The page limit of the application is 70 pages.
Eligibility conditions	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. In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security in the area of research covered by this topic, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway and the United Kingdom and to International European Research Organisations. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.
Technology Readiness Level	Activities are expected to achieve TRL7 (areas 11, 14B, 15, 29) and TRL5 (area 9A) by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the additional exploitation obligations: For a period of up to 4 years after the end of the project, access rights to the use of products and/or processes generated by the project shall be given to European entities, in compliance with the signed Grant Agreement and with no legal restrictions and limitations stemming from International Traffic in Arms Regulations (ITAR), EAR99 or equivalent instruments applicable in other jurisdictions. Applicants must acknowledge and incorporate this obligation in the

	proposal and Annex I to the Grant Agreement.

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 medium 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 European Commission-EDA-ESA Joint Task Force (JTF) list of Actions 2021-2023 shall be implemented for the following technology areas.

- **[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.

Proposals should address only one area. To ensure a balanced portfolio covering the 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.

Activities should be complementary and create synergies 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. An assessment of commercial viability of the supply chain should be done. Identification of critical dependencies and, if applicable, a business plan for commercialization, including time to market indication, of the developed product and/or full range of recurring products should be included.

To achieve 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Unless otherwise agreed with the granting authority, beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners or subcontractors are established in countries which are not eligible countries or target countries set out in the call conditions

HORIZON-CL4-2022-SPACE-01-82: Space science and exploration technologies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL3-4 by the end of the project – see General Annex B.

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

- Enable breakthroughs in technologies and scientific instrumentation for space science and exploration missions including those described in the Global Exploration Roadmap from the International Space Exploration Coordination Group (ISECG).

- Validation of novel space/planetary robotic technologies and instrumentation through analogue tests.
- Increased collaboration of scientific, engineering and industrial teams both within and outside Europe across different domains.
- To strengthen European scientific excellence and support the development of leading edge scientific and technologic research in Europe

Scope: The development of innovative instrumentation (payload) and technologies enabling space science and exploration missions requires timely technology development associated with future space science and exploration missions, including robotic exploration technologies, early stage scientific instrumentation and component technologies for space resources utilisation and space observatories. The development of new and innovative approaches, such as instruments for 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 innovative measurement techniques, increased sensitivity, increased robustness, faster and more accurate data processing or in-situ sample and data analysis.

The proposed activities should target primarily European and European-led space science and exploration missions or international missions where the participation of European partners provides demonstrated added value in technological development and scientific output.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

DESTINATION – 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. As outlined in the White Paper on Artificial Intelligence (COM(2020)65), 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 could 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 survey[249] shows that half of the 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, 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 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

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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[250].

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

Call	Budgets (EUR million)		Deadline(s)
	2021	2022	
HORIZON-CL4-2021-HUMAN-01	206.00		21 Oct 2021
HORIZON-CL4-2022-HUMAN-01		70.50	05 Apr 2022
HORIZON-CL4-2022-HUMAN-02		50.50	16 Nov 2022
Overall indicative budget	206.00	121.00	

[250] 2019 CIGI-Ipsos Global Survey on Internet Security and Trust

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)[251]

Topics	Type of Action	Budgets (EUR million) 2021	Expected EU contribution per project (EUR million)[252]	Number of projects expected to be funded
Opening: 22 Jun 2021 Deadline(s): 21 Oct 2021				
HORIZON-CL4-2021-HUMAN-01-01	RIA	36.00	Around 4.00	9
HORIZON-CL4-2021-HUMAN-01-02	CSA	13.00	4.00 to 9.00	2
HORIZON-CL4-2021-HUMAN-01-03	RIA	9.00	Around 9.00	1
HORIZON-CL4-2021-HUMAN-01-04	RIA	12.00	Around 12.00	1
HORIZON-CL4-2021-HUMAN-01-05	RIA	17.00	Around 8.50	2
HORIZON-CL4-2021-HUMAN-01-06	IA	26.00	8.00 to 9.00	3
HORIZON-CL4-2021-HUMAN-01-07	CSA	2.00	Around 2.00	1
HORIZON-CL4-2021-HUMAN-01-08	CSA	2.00	Around 2.00	1
HORIZON-CL4-2021-HUMAN-01-09	CSA	1.50	Around 1.50	1
HORIZON-CL4-2021-HUMAN-01-13	RIA	14.50	Around 4.80	3
HORIZON-CL4-2021-HUMAN-01-14	RIA	6.00	Around 6.00	1

251 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.

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

HORIZON-CL4-2021-HUMAN-01-17	CSA	1.00	Around 1.00	1
HORIZON-CL4-2021-HUMAN-01-18	CSA	1.00	Around 1.00	1
HORIZON-CL4-2021-HUMAN-01-19	CSA	5.00	Around 5.00	1
HORIZON-CL4-2021-HUMAN-01-20	CSA	2.00	Around 2.00	1
HORIZON-CL4-2021-HUMAN-01-21	RIA	8.50	Around 2.80	3
HORIZON-CL4-2021-HUMAN-01-24	RIA	10.00	3.00 to 3.50	3
HORIZON-CL4-2021-HUMAN-01-25	IA	14.00	5.00 to 8.00	2
HORIZON-CL4-2021-HUMAN-01-26	RIA	5.00	Around 5.00	1
HORIZON-CL4-2021-HUMAN-01-27	RIA	13.00	Around 6.50	2
HORIZON-CL4-2021-HUMAN-01-28	CSA	2.50	Around 2.50	1
HORIZON-CL4-2021-HUMAN-01-29	CSA	2.50	Around 2.50	1
HORIZON-CL4-2021-HUMAN-01-30	CSA	1.50	Around 1.50	1
HORIZON-CL4-2021-HUMAN-01-31	CSA	1.00	Around 1.00	1
Overall indicative budget		206.00		

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

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 (AI, Data and Robotics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio 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 also to the three highest ranked proposals in the research area addressing novel or promising approaches to advance "intelligence" and autonomy of AI-based systems, and at least to the top ranked proposal within each of the four other research areas, provided that the applications attain all thresholds.

Expected Outcome: Proposal results are expected to contribute to at least one of the following expected outcomes:

- World-class transparent, explainable, accountable and trustworthy AI, based on smarter, safer, secure, resilient, accurate, robust, reliable and dependable solutions.
- Improved AI solutions aiming to meet the industrial[253] requirements in terms of autonomy, accuracy, safety, repeatability, robustness, resilience, security, etc.
- Greener AI.
- Next level of AI-based solutions, exploiting the intelligence embedded in the edge-to cloud infrastructure

[253] Including all industries from manufacturing to service, both public and private.

- Advances in complex systems & socially aware AI

Scope: Develop **trustworthy AI** technology, key for acceptance, to take full advantage of the huge benefits such technology can offer, and demonstrate the benefits 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 investigate approaches such as 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, etc.

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 Commission 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 robotics and non-embodied AI systems. This will include, among others, 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 users' 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 (data efficient 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 (for which synergies with the European Partnership for Key Digital Technologies (KDT) is encouraged), 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.

Proposals should clearly identify its focused research area among the 5 listed above.

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, modelling, analysing, operating, monitoring, integrating, maintaining and extending AI systems.

In all these topics, involvement of multidisciplinary teams and transdisciplinary research, including SSH as appropriate, 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 competitiveness[254].

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 platform[255], a public community resource, to maximise re-use of results and efficiency of funding.

Activities are expected to achieve TRL 4-5 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 destinations 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.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

HORIZON-CL4-2021-HUMAN-01-02: European coordination, awareness, standardisation & adoption of trustworthy European AI, Data and Robotics (AI, Data and Robotics Partnership) (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
Type of Action	Coordination and Support Actions
Procedure	The procedure is described in General Annex F. The following exceptions

[254] https://ec.europa.eu/digital-single-market/en/artificial-intelligence#Coordinated-EU-Plan-on-Artificial-Intelligence

[255] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

	apply: To ensure a balanced portfolio covering the two complementary types of activities defined in this topic to coordinate and support the field of AI, Data and Robotics, grants will be awarded to applications not only in order of ranking but at least also to the highest ranked proposal amongst the first type of proposals (see focus 1 under Scope), and to the highest ranked proposal amongst the second type of proposals (see focus 2 under Scope), provided that the applications attain all thresholds.

Expected Outcome: Proposal results are expected to contribute to either of the following expected outcomes, depending on their focus (the proposals should focus on one of the two expected outcomes exclusively):

1. Outcome 1:

    a. Efficient AI, Data and Robotics Public-Private Partnership supporting the community and the implementation of the SRIDA[256].

    b. Reinforced links among initiatives in AI, Data and Robotics in H2020, Horizon Europe, Digital Europe Programme, and other programmes (Networks of excellence centres, DIHs, pilots, data platforms, and other projects).

    c. Widespread educational and outreach programmes

    d. Increased adoption of AI technologies in all Member States and Associated Countries, towards elimination of gaps between Member States and Associated Countries.

    e. Increased adoption of trustworthy AI, data and robotics in procurement both public and private (B2B, B2C, B2G, etc.)

    f. Standardisation methods for trustworthy and ethical AI to foster AI, data and robotics industry, and in support of the Commission regulatory framework.

2. Outcome 2: Efficient support to the research community via the AI-on-demand-platform[257], a public community resource.

Scope: The proposals should address one of the following focus areas:

Focus 1) the first type of proposals (EU contribution around EUR 4.00), will address the following aspects:

[256] Strategic Research, Innovation and Deployment Agenda of the AI, Data and Robotics PPP

[257] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

- 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.

- Coordinate and establish links with all relevant initiatives in AI, Data and Robotics in Horizon 2020, Horizon Europe, Digital Europe Programme, and other programmes (Networks of excellence centres, DIHs, pilots, data platforms, and other projects), in view of sharing knowledge, developing synergies, and coordinate the efforts when possible. Synergies should be developed with the relevant projects through efficient mechanisms (e.g. joint task forces), organisation of joint events gathering projects, etc.

- 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 in digital competences and access 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.

- 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.

- 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 Commission regulatory framework.

    - Standards should guarantee that AI, data and robotics 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, data and robotics throughout the system lifecycle and make sure that decision systems are trustworthy by being robust, un-biased, safe and secure.

- Developing a coherent and broadly accepted set of AI, data and robotics 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.

- 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 standardisation, in particular building on on-going activities in European Standardization Organizations (ESOs) and other relevant standardisation initiatives.

- 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 standardisation, certification and regulation

- Recommendations for research and innovation activities supporting standardization

One large CSA is expected to cover all the aspects above. Close cooperation is expected with the second CSA supporting the AI-on-demand platform.

Focus 2) the second type of proposals (EU contribution around EUR 9.00), will address the following aspects:

The second type of CSA proposals will be in charge of the maintenance and necessary developments and services provision for the AI-on-demand-platform[258], a public community resource, with a focus on supporting the research community. Such platform should support

[258] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

the research community in providing modules, codes, tools, knowledge base to share and continuously strengthen the S&T excellence. It should also provide the necessary access to resources (data, compute power, equipment, etc.) to offer the AI, Data and Robotics R&D community an environment in which to develop new solutions and to ensure a leading position to Europe in S&T in these fields. It should also implement methods to compare solutions, and demonstrate progress. Proposals should demonstrate how their methodology will promote excellence, by serving the needs of the scientific community. In close cooperation with the first Coordination and Support Action, it will further develop the platform services that offer a common portal gathering relevant information, success stories, etc. The activities of this AI-on-demand-platform funded through Horizon Europe will serve the needs of the research community while the AI-on-demand platform funded through the Digital Europe Programme will focuses on AI tools at higher TRLs, to serve the needs of the market. Synergies will be developed between the two platforms to ensure complementarity and avoid overlaps. Results from this platform should be transferred to the other platform, after reaching sufficient level of maturity.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership. Proposals should include activities to collaborate with projects stemming from topics relevant to AI, Data and Robotics, primarily in destinations 3, 4 and 6 of Cluster 4, but also in other destinations and clusters, and share or exploit results where appropriate. Proposals should also develop synergies with relevant activities in Digital Europe Programme.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-03: European Network of AI Excellence Centres: Pillars of the European AI lighthouse (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant	The rules are described in General Annex G. The following exceptions apply:

Agreements	Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 60 000.

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

- Establishing a new pillar of the European AI lighthouse[259]
- Reinforcing a leading unified European AI community
- Scientific progress in AI, addressing major challenges hampering its deployment.

Scope: To ensure European open strategic autonomy in critical technologies such as AI, 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.

Europe has undeniable strengths with its many leading research centres, but the efforts are scattered.

As stated in the communication from the European Commission on Artificial Intelligence for Europe [260] and the coordinated action plan between the European Commission and the Member States and Associated Countries[261], joining forces will be crucial for international competitiveness. 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; therefore, reinforcing excellence through collaboration in AI throughout Europe.

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.

To complement and extend the initiative started in H2020 to develop a vibrant European network of AI excellence centres, and a vibrant AI scientific community, the proposals should create a network of excellence for the following topic:

Safe and secure AI **addressing safety and security by design**: foster the collaboration between AI with safety engineering communities, security, cybersecurity and related

259 In this section AI is taken in the broad sense and covers AI, Data and Robotics
260 https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe
261 https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6689

communities, to develop safe-by-design and secure-by-design AI, data and robotics systems, contributing to safety and security of citizens and any users of such AI-powered systems. The focus is on research, but the work should also contribute to good practices, standards and certification, complying with regulations for AI safety and protection of fundamental rights.

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.

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, multidisciplinarity and developing academia-industry synergies, as relevant.

Composition of the Network:

- It should be driven by leading researchers in AI and AI relevant technologies from major excellent AI research centres, and bringing the best scientists across Europe, including also from promising research labs. It will bring on board the necessary level of expertise and variety of disciplines and profiles to achieve their objectives, ensuring a multidisciplinarity and multi-sectorial research approach, while respecting equality and diversity among the attracted talents.

Activities of the Network:

- 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.

- The 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, with a maximum of 60k€ per third party[262]).

- The network will develop, where relevant, interactions with the industry, in view of triggering new scientific questions and fostering take-up of scientific advances

- The network will develop collaboration with the relevant Digital innovation Hubs, World-class reference testing facilities, AI regulatory sandboxes and AI start-up initiatives, to disseminate knowledge and tools, and understand their needs.

- The network should also foster innovation and include mechanisms to exploit new ideas coming out of the network's work (for instance via incubators, start-up and spinoff initiatives and university tech-transfer funds).

- 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.

<u>The proposals should:</u>

- 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

- provide access to the required resources and infrastructure to support the R&D activities of the action, such as cloud and computing capacity, IoT, robotics equipment, support staff and engineers, where relevant, and the capacity to develop prototypes, pilots, demonstrators, etc.

- 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,

[262] Maximum amount per third party, received from a given Action, over its entire duration

benchmarking and progress monitoring processes) towards solving the targeted challenges will motivate the entire network and support publications and scientific career developments (providing reference benchmarks 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.

- 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 platform[263] 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. Openness and interoperability of components are encouraged to develop synergies and cross-fertilization between different approaches and solutions (e.g. through modularity of components or open interfaces).

- 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 and Associated Countries, with particular emphasis on geographical aspect and elimination of gaps in digital competences and access between Member States and Associated Countries, as well as addressing existing gender disparities.

- exploit and develop technology enablers, such as methodologies, tools and systems and exploit latest hardware development and data spaces, cloud and HPC resources.

Activities are expected to achieve TRL 4-5 by the end of the project.

Proposals are expected to develop synergies:

- With other Networks of excellence centres in AI funded in H2020 or Horizon Europe, with a view of, all together, create vibrant European network of AI excellence centres. To that end, the activities should integrate with and complement the activities of the H2020-ICT-48 projects. The proposals are expected to dedicate tasks to ensure this coherence.

- With relevant activities in AI, Data and Robotics, primarily in destinations 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.

[263] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

Background

The network of excellence centres on AI safety and security will contribute to the larger objective of the European Commission to establish the **European AI lighthouse**.

The AI lighthouse is expected to mobilise the AI community 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. This is essential to reach critical mass and overcome the present fragmentation of AI research in Europe.

The lighthouse will bring together **stakeholders from research, innovation and deployment**, to become a **world reference in AI** that can attract investments and the best talents in the field. The lighthouse will build on key pillars, each of them being a network of excellence centres specialising in a given topic where Europe has the potential to become a global champion. The initiative started with the H2020-ICT-48 call establishing the first networks of excellence centres and will further develop in Horizon Europe.

HORIZON-CL4-2021-HUMAN-01-24: Tackling gender, race and other biases in AI (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 3.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	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: Proposal results are expected to contribute to the following expected outcomes:

- 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.

Bias in AI can occur in three dimensions: training data, bias in algorithms, and bias in the interpretation of the results. This topic investigates preventing and mitigating bias in AI, focusing on (1) recommender and personalisation systems, (2) algorithmic decision-making, and (3) surveillance software, including facial recognition. Proposals may focus on more than one of these AI-based systems and should clearly identify the expected use-case/s in society.

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 benefit[264] 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' priority to strive for a 'Union of Equality', the European Pillar of Social Rights,[265] the Gender Equality Strategy 2020 – 2025,[266] the EU Anti-racism Action Plan 2020-2025[267], and the LGBTIQ Equality Strategy 2020-2025[268], proposals are expected to:

- 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.

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264 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.

265 The European Pillar of Social Rights: https://ec.europa.eu/commission/sites/beta-political/files/social-summit-european-pillar-social-rights-booklet_en.pdf

266 Gender Equality Strategy 2020 -2025: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0152&from=EN

267 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

268 https://ec.europa.eu/info/files/lgbtiq-equality-strategy-2020-2025_en

- Develop standardized processes to assess and quantify the trustworthiness of the developed AI systems, in particular assessment of bias, diversity, non-discrimination and intersectionality[269] – 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.[270] 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 the selected use-case

- 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.[271] 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 Robotics[272] and other relevant initiative and projects (such as the AI-on-demand platform).

- Cooperate with the Public-Private Partnership on AI, Data and Robotics[273] 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). 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

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269 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.

270 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

271 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

272 https://ai-data-robotics-partnership.eu/

273 https://ai-data-robotics-partnership.eu/

with the European R&D community, through the AI-on-demand platform, as well as the GEAR[274] 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 2021-202 WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA[275].

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

HORIZON-CL4-2021-HUMAN-01-27: AI to fight disinformation (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3-4 and achieve TRL 5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering different types of advanced AI solutions against disinformation, grants will be awarded not only in order of ranking but at least also to the highest ranked proposal addressing each of the two expected outcomes (1. Advanced AI solutions against advanced disinformation techniques for media professionals, and 2. Advanced AI solutions against disinformation for citizens), provided that the applications attain all thresholds.

274 https://eige.europa.eu/gender-mainstreaming/toolkits/gear

275 In particular: HORIZON-WIDERA-2021-ERA-01-91. ENSURING RELIABILITY AND TRUST IN QUALITY OF RESEARCH ETHICS EXPERTISE IN THE CONTEXT OF NEW/EMERGING TECHNOLOGIES.

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

- Advanced AI solutions against advanced disinformation techniques for media professionals.
- Advanced AI solutions against disinformation for citizens.

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 **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 respond to one of the following:

1. **Advanced 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 AI and computer science, 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.

2. **Advanced AI based solutions targeted to citizens** for securing a trustworthy online environment. The solutions should foster citizens' ability to identify, verify and combat disinformation through AI innovation. Solutions provided would include the analysis and tracing of various forms of content, correlation/comparison of various sources of information, exploitation of contextual information. Efficient and intuitive mechanisms to convey the information regarding quality/veracity of information should be addressed, as appropriate. Transparency and human oversight would be key, with a view of empowering citizens.

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 clearly identify the expected outcome it will focus on (i.e. targeting media professionals or citizens).

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[276], Fandango[277]) 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 proposals. Proposals should foresee activities to collaborate with projects stemming from the topics HORIZON-CL3-2021-FCT-01-03: Disinformation and fake news are combated and trust in the digital world is raised.

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 TRL5-6 by the end of the project

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

[276] https://cordis.europa.eu/project/id/951911
[277] https://cordis.europa.eu/project/id/780355

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	N.A. (not applicable)
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As the main objective of the action is to support large number of third parties through open calls, the maximum amount to be granted to each third party is EUR 500 000 to allow cases were a given legal entity (e.g. large research, academic or industrial organisations) may receive several grants (e.g. from different calls).

Expected Outcome: Proposal 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, interoperable, 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.

Proposals 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, levering 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 sets and allow the users to transfer or share such data with organisations of their choice for purposes and under conditions they decide and control (e.g. data altruism). Proposals should contribute to a trusted digital identity ecosystem that is in line with the European regulatory framework, platform-independent and user-centric and contributes to building a secure European digital identity. The purpose is to enable individuals to effectively own, manage and control their digital identity and make it their passport to the digital society.

The proposals 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 2021-DATA-01-01, 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. 2021-CS-01-04, 2021-FCT-01-01, 2022-BM-01-02).

Financial support to third parties

The consortium should support third party projects from outstanding open source innovators, academic research groups, high-tech start-ups, 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 should 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 should 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 150 000 range per project, with indicative duration of 9 to 12 months.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-05: Trustworthy open search and discovery (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 17.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	N.A. (not applicable)
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering a broad range of research areas and approaches, grants will be awarded to applications not only in order of ranking but at least also to the highest ranking proposal in the first research area, addressing advanced methods of search, and to the highest ranking proposal in the second research area, addressing search infrastructures, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As the main objective of the action is to support large number of third parties through open calls, the maximum amount to be granted to each third party is EUR 500 000 to allow cases were a given legal entity (e.g. large research, academic or industrial organisations) may receive several grants (e.g. from different calls).

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

- Empowered citizens and companies able to search and discover information, data, smart objects, resources and people online, with increased security, 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 business and sustainability models based on improved access to online data, smart objects and resources and on open source.

Scope: The objective of this topic is to develop technologies and solutions 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 smart objects, services, multimedia content, intranets and other IT resources, both public and private. It is also to empower end-users, including through agents acting on their behalf, to share and discover more data and reliable information sources, while preserving their privacy and increasing public trust in search results.

Proposals should focus on advancing the state-of-the-art in one of the two research areas below:

1. Advanced methods of search and discovery 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 under this research area 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. As the primary purpose of this research area 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. Beneficiaries should 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.

2. Improving search and discovery infrastructures, with a view to increasing European sovereignty in future search, discovery and recommendation systems. Projects could notably design and pilot distributed search infrastructures, with a strong focus on sustainability, security, reliability, interoperability and trust. Proposals under this research area will incorporate third party contributions from outstanding open source innovators, academic research groups, high-tech startups, SMEs, and other multidisciplinary actors. A minimum of 15% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

Proposals should clearly identify the research area they are addressing.

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. The focus of this topic is on advanced research; apps and services that innovate without a research component are not covered by this topic. 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

The consortium should 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.

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 150 000 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

	proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposal 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.
- Broad understanding and support for the NGI vision of a human-centric Internet

Scope: The proposal 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 should 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 should seek to ensure through dedicated activities diverse participation in terms of profiles, gender, age, ethnic group, abilities, and nationality (including from neighbouring regions). It should have dedicated activities to promote the involvement of women innovators.

The proposal should 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.

The Commission considers that proposals with an overall duration of 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations.

HORIZON-CL4-2021-HUMAN-01-08: NGI International Collaboration - Transatlantic fellowship programme (CSA)

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

Type of Action	Coordination and Support Actions
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 60 000.

Expected Outcome: Proposal 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 should be on trust and data sovereignty and on internet architecture renovation and decentralised technologies.

The proposal 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.

These should be 3 to 6 months fellowships for Internet researchers, notably open source developers, 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. The proposal should only provide financial support for travel and subsistence, and only citizens of the EU and associated countries will be eligible for funding. As the primary purpose of the action is to support and mobilise internet innovators, a minimum of 70% of the total requested EU contribution should be allocated to financial support to third parties, selected through open calls.

The Commission considers that proposals with an overall duration of 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-09: NGI Tech Review (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 1.50 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposal 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 internet innovators to develop, test and improve solutions based on open source technologies.

Scope: The COVID-19 crisis demonstrates that complex challenges of today cannot be solved by one organisation or by one country, and they require the support of digital technologies. Open collaboration of innovators from multiple backgrounds supporting values such us protection of privacy, inclusiveness and transparency 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 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 quality, security, accessibility, privacy, open source licensing, or documentation. The funding does not cover the funding of innovators to develop new solutions.

The Commission considers that proposals with an overall duration of 36 months would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

eXtended Reality (XR)

Proposals are invited against the following topic(s):

HORIZON-CL4-2021-HUMAN-01-13: eXtended Reality Modelling (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.80 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 300 000 to further extend the use-cases and the application domains, address sector specific constraints, ensure reproducibility and demonstrate their integration paths.

Expected Outcome: Proposals 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, tools and processes 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. Natural language Understanding and Natural Language Generation state-of-art techniques are expected to take advantage of the latest advances in research. 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 proposals will:

- Develop pre-trained eXtended Reality 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, believes, 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 proposal 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 constrains, ensure reproducibility and demonstrate their integration paths, proposals 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Proposals 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 impaired[278] and especially the deafblind for whom touch and feel are the only form of communication;
- Establish Europe as a world leader in developing accessibility solutions.

Scope: eXtended Reality, 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, 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 proposal will develop an affordable, portable, usable full-page device able to convey and input digital information in both braille and tactile graphics for people with visual impairments.

[278] The European Blind Union estimates that there are over 30 million blind and partially sighted persons in geographical Europe.

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.

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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-25: eXtended Collaborative Telepresence (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6-7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 200 000 to further extend the application domains, guarantee reproducibility and demonstrate the integration paths for take-up by European industries.

Expected Outcome: Proposals are expected to contribute to the following outcome:

- Establishing European industry leadership in eXtended collaborative telepresence solutions, while ensuring ethics, privacy, security 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, 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;
- Overcome the limitations of the current technologies handling large number of simultaneous users;
- 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 and sharing meeting recording speech transcription, translation, anonymisation, summarisation, context-aware instant search;
- Optimise the results of eXtended collaborative meetings through easy access, analysis and syntheses of recordings;
- Ensure security and 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, avoiding vendor lock-in.

- 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, proposals 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-06: Innovation for Media, including eXtended Reality (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 9.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 26.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 8 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties.

	The support to third parties can only be provided in the form of grants. As the main objective of the action is to set up a dedicated VR Media Lab to foster innovation and new solutions in the field of VR/AR Media, the maximum amount to be granted to each third party is EUR 500 000 for accommodating substantial equipment investment.

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.
- 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[279].

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 ground-breaking 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

[279] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0784

the opportunity to the proposals 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 (Max Contribution of EUR 9 million).

One proposal will be funded for type ii (Max Contribution of EUR 8 million).

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 should 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 30 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.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-28: eXtended Reality Ethics, Interoperability and Impact (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.50 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposals 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, security and safety.

Scope: New ethical risks, security and privacy concerns arise as experiences based on eXtended Reality 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 proposal 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 1.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposals 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, signpost 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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 1.00 million.
Type of Action	Coordination and Support Actions

Expected Outcome: Proposals 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.
- Helping in the development of agile standards by identifying the major bottlenecks of the standard-setting process.

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 (CSA)

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

Expected Outcome: Proposals 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 could 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.

HORIZON-CL4-2021-HUMAN-01-20: Piloting a new industry-academia knowledge exchange focussing on companies' needs (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Coordination and Support Actions
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties.

	The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 60 000.

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

- Stronger industrial ecosystems in Europe through reinforced industry-academia collaboration.
- Enhanced use of the European pool of talents and skills supporting 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-academia 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 resilience[280].

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 support for ad-hoc collaborations focussing on companies' specific needs. This activity will develop and pilot a standard collaboration module that will support short-term gender-balanced co-creation teams of HEI[281] students, researchers and companies own R&D personnel to work jointly to solve the company's identified R&I and business challenges. The applicants should elaborate how they will develop this in coordination with the European Institute of Innovation and Technology (EIT) to avoid duplication, explore complementary forms and means of service provisions distinct to the EIT KICs, and allow possible use of existing EIT networks. The minimum number of co-creation teams that need to be supported in a geographically balanced way is 300. 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 action should create links with other relevant initiatives related to industry-academia collaboration.

The co-creation process will be facilitated by a collaborative module 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 to the company's identified

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challenge. The collaborative module will be in charge of matching the company's needs with individuals to form a bespoke and fit-for-purpose interdisciplinary diverse team to tackle the particular challenge. Furthermore, the module 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 4-8 weeks. If applicants propose to provide financial support to third parties to support co-creation teams they will need to describe conditions for submission, evaluation and selection of proposals of third parties.

HORIZON-CL4-2021-HUMAN-01-21: Art-driven use experiments and design (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.80 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 80 000 in order to allow artists and end-users/providers of novel technologies to collaborate in art-driven experiments.

Expected Outcome: Dedicated collaboration of industry with artists in R&D projects will lead to novel products and services in line with a human-centred approach to innovation and with sustainability goals. Proposals should bring together artistic practices with the technological expertise provided by the consortium. This will:

- Stimulate uptake of digital technologies across selected sectors - (Green) Manufacturing, Mobility/Urbanism, Health, Agriculture, Energy and Space through art-driven experimentations to address social, business or sustainability challenges in the chosen sector(s).

- Increase trust in and acceptance of digital technologies in society through art-driven design and development of digital technologies. The development process and system

behaviour of the technologies should explicitly acknowledge human values and needs and thereby enable social inclusion and environmentally friendly innovation.

Scope: Design of technology and deployment in selected sectors will be explored through use cases between stakeholders in industry – engineers, developers –, end-users and artists though dedicated industrial projects in continuation of the S+T+ARTS residencies and S+T+ARTS lighthouse pilots[282]. The role of the arts will be to (i) conceive challenging human-centred use scenarios, (ii) explore alternative design methods and use scenarios 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 Artificial Intelligence. Calls will be open to research and technology institutions, companies, and SMEs willing to provide access to selected (digital) technologies and to connect to the arts.

The consortium will provide technical support and access to a range of digital technologies for art-driven experimentation and support via financial support to third-parties for art-driven experimentation. The support to third parties can only be provided in the form of grants to: (a) artists interested to explore and to work with technologies to enhance their usability and uptake and (b) artists and end-users/providers of novel technologies collaborating in art-driven experiments. Third parties will be funded through projects typically up to EUR 40 000 per project for type (a) and EUR 80 000 per project for type (b) (30% of which to artists). At least EUR 400 000 of the requested EU contribution should be dedicated to financial support to third parties of type (a) and at least EUR 800 000 to type (b).

HORIZON-CL4-2021-HUMAN-01-29: Support for transnational activities of National Contact Points in the thematic area of Digital (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.50 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: Applicants must be Horizon Europe national support structures (e.g. NCP) responsible for the Cluster 4 thematic area of Digital and officially nominated to the

[282] www.STARTS.eu

	Commission, from a Member State or Associated Country. Only in case and as long as Horizon Europe structures would not yet be officially nominated, national support structures responsible for Information and Communication Technologies (ICT) nominated for Horizon 2020 would be eligible.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Improved and professionalised NCP services across Europe, in the respective thematic area, thereby supporting 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;
- Facilitating participation of new players in projects in this thematic area;
- Matchmaking activities to link up potential participants from widening countries with emerging consortia in this thematic area. Matchmaking should use a variety of possible tools;
- Increased cooperation of NCPs with the Enterprise Europe Network.

Scope: Proposals should facilitate trans-national co-operation amongst National Contact Points (NCPs) in the respective thematic area, encouraging cross-border activities, sharing good practices and raising the general standard of support to programme applicants.

Proposers may wish to foresee specialised services covering the respective thematic area, drawing on the expertise of the predecessor network. At the same time, proposers must closely collaborate with the proposals in the two other thematic areas of the cluster,[283] to ensure the cohesion of the services in the three thematic areas of Digital, Industry and Space, with a single entry point and common visual identity. Proposers should also share good practices across thematic areas; and enhance opportunities for collaboration across the cluster. A dedicated work package should be developed to ensure these synergies.

Given the importance of human-centric approaches in this cluster, the proposal 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. Where

[283] Topics HORIZON-CL4-2021-HUMAN-01-30,31

relevant, synergies should be sought with the Enterprise Europe Network to organise matchmaking activities in accordance with Annex IV of the NCP Minimum Standards and Guiding Principles.

The proposal should cover 36 months, with the possibility to renew to the whole duration of Horizon Europe.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-30: Support for transnational activities of National Contact Points in the thematic area of Industry (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 1.50 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: Applicants must be Horizon Europe national support structures (e.g. NCP) responsible for the Cluster 4 thematic area of Industry and officially nominated to the Commission, from a Member State or Associated Country. Only in case and as long as Horizon Europe structures would not yet be officially nominated, national support structures responsible for Nanotechnologies, Advanced Materials and Advanced Manufacturing and Processing nominated for Horizon 2020 would be eligible.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Improved and professionalised NCP services across Europe, in the respective thematic area, thereby supporting 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;

- Facilitating participation of new players in projects in this thematic area;
- Matchmaking activities to link up potential participants from widening countries with emerging consortia in this thematic area. Matchmaking should use a variety of possible tools;
- Increased cooperation of NCPs with the Enterprise Europe Network.

Scope: Proposals should facilitate trans-national co-operation amongst National Contact Points (NCPs) in the respective thematic area, encouraging cross-border activities, sharing good practices and raising the general standard of support to programme applicants.

Proposers may wish to foresee specialised services covering the respective thematic area, drawing on the expertise of the predecessor network. At the same time, proposers must closely collaborate with the proposals in the two other thematic areas of the cluster,[284] to ensure the cohesion of the services in the three thematic areas of Digital, Industry and Space, with a single entry point and common visual identity. Proposers should also share good practices across thematic areas; and enhance opportunities for collaboration across the cluster. A dedicated work package should be developed to ensure these synergies.

Given the importance of human-centric approaches in this cluster, the proposal 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. Where relevant, synergies should be sought with the Enterprise Europe Network to organise matchmaking activities in accordance with Annex IV of the NCP Minimum Standards and Guiding Principles.

The proposal should cover 36 months, with the possibility to renew to the whole duration of Horizon Europe.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-31: Support for transnational activities of National Contact Points in the thematic area of Space (CSA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 1.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal

[284] Topics HORIZON-CL4-2021-HUMAN-01-29,31

	requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 1.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: Applicants must be Horizon Europe national support structures (e.g. NCP) responsible for the Cluster 4 thematic area of Space and officially nominated to the Commission, from a Member State or Associated Country. Only in case and as long as Horizon Europe structures would not yet be officially nominated, national support structures responsible for Space nominated for Horizon 2020 would be eligible.
Procedure	The procedure is described in General Annex F. The following exceptions apply: The granting authority can fund a maximum of one project.

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

- Improved and professionalised NCP services across Europe, in the respective thematic area, thereby supporting 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;
- Facilitating participation of new players in projects in this thematic area;
- Matchmaking activities to link up potential participants from widening countries with emerging consortia in this thematic area. Matchmaking should use a variety of possible tools;
- Increased cooperation of NCPs with the Enterprise Europe Network.

Scope: Proposals should facilitate trans-national co-operation amongst National Contact Points (NCPs) in the respective thematic area, encouraging cross-border activities, sharing good practices and raising the general standard of support to programme applicants.

Proposers may wish to foresee specialised services covering the respective thematic area, drawing on the expertise of the predecessor network. At the same time, proposers must closely collaborate with the proposals in the two other thematic areas of the cluster,[285] to ensure the cohesion of the services in the three thematic areas of Digital, Industry and Space,

[285] Topics HORIZON-CL4-2021-HUMAN-01-29,30

with a single entry point and common visual identity. Proposers should also share good practices across thematic areas; and enhance opportunities for collaboration across the cluster. A dedicated work package should be developed to ensure these synergies.

Given the importance of human-centric approaches in this cluster, the proposal 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. Where relevant, synergies should be sought with the Enterprise Europe Network to organise matchmaking activities in accordance with Annex IV of the NCP Minimum Standards and Guiding Principles.

The proposal should cover 36 months, with the possibility to renew to the whole duration of Horizon Europe.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2021-HUMAN-01-26: Workforce skills for industry 5.0 (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Proposals 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 should 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)[286]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[287]	Number of projects expected to be funded
		2022		
Opening: 21 Dec 2021 Deadline(s): 05 Apr 2022				
HORIZON-CL4-2022-HUMAN-01-03	RIA	22.00	Around 11.00	2
HORIZON-CL4-2022-HUMAN-01-05	RIA	2.00	Around 2.00	1
HORIZON-CL4-2022-HUMAN-01-07	RIA	6.00	Around 6.00	1
HORIZON-CL4-2022-HUMAN-01-14	RIA	19.00	5.00 to 8.00	3
HORIZON-CL4-2022-HUMAN-01-19	IA	21.50	5.00 to 8.00	3
Overall indicative budget		70.50		

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

286 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.

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

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

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	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 11.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	N.A. (not applicable)
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering a broad range of research areas and approaches, grants will be awarded to applications not only in order of ranking but at least also to the highest ranking proposal in the first research area, addressing Internet architecture, and to the highest ranking proposal in the second research area, addressing Blockchain and DLT, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As the main objective of the action is to support large number of third parties through open calls, the maximum amount to be granted to each third party is EUR 500 000 to allow cases were a given legal entity (e.g. large research, academic or industrial organisations) may receive

	several grants (e.g. from different calls).

Expected Outcome: Proposal 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 open 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 efficiency 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 small number of platforms controlling end-users' data, online transactions and infrastructure, effectively leading to a concentration and centralisation of the Internet.

Proposals should focus on advancing the state-of-the-art in one of the two research areas below:

1. To review and upgrade the open Internet architecture (hardware, software, protocols) to increase the performance of the network, adapt it to new application requirements, improve quality of service, make it more resilient to security threats, more energy efficient and respectful of the environment (e.g. reparability, recyclability), and increasingly supportive of open and decentralised technologies and services.
2. Address the current limitations of decentralised technologies, such as Blockchain and DLT, including those related to scalability, interoperability, energy efficiency, privacy or security, in order to make them dependable building blocks of the future Internet. This research area 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 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 concerning data provenance and authentication with (real-time) traceability, data

integrity, data exploitation as well as data protection and privacy when it relates to individuals.

Proposals should clearly identify the research area they are addressing.

The focus is on advanced research that is linked to new technology breakthrough and real-life applications or use cases. However, apps and services that innovate without a research component are not covered by this topic. Proposals funded under this topic should include standardisation activities to promote the technologies developed in international standard setting organisations.

The proposals 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

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 should 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 should 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 150 000 range per project, with indicative duration of 9 to 12 months.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

HORIZON-CL4-2022-HUMAN-01-05: Next Generation Safer Internet: Technologies to identify digital Child Sexual Abuse Material (CSAM) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 2.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Proposal 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 Law Enforcement Agencies (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 proposals 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 should 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 should be involved in each project. Working in close cooperation with them, the proposals should build on existing infrastructures and processes already available to LEAs and INHOPE Hotlines. The proposals should ensure European added value through cross-border interoperability.

The proposals should 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 should 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[288], which advances 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 and Canada (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	N.A. (not applicable)
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. As the main objective of the action is to support large number of third parties through open calls, the maximum amount to be granted to each third party is EUR 500 000 to allow cases were a given legal entity (e.g.

[288] HORIZON-CL3-2021-FCT-01-11: Prevention of child sexual exploitation

	large research, academic or industrial organisations) may receive several grants (e.g. from different calls).

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

- Enhanced EU cooperation with the US and Canada 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.
- An EU-US-Canada ecosystems of top researchers, hi-tech start-ups / 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 cooperation and strategic partnerships with the US and Canada in the area of Next Generation Internet, and to establish a continuous dialogue among the actors involved in the US, Canadian and EU programmes, in particular as far as internet standardisation is concerned. The focus should be on trust and data sovereignty, in particular digital identity, and on internet architecture renovation and decentralised technologies.

A RIA will organise open calls for joint projects involving EU teams together with USA and/or Canadian teams on emerging topics for the EU Next Generation Internet and corresponding US and Canadian programmes, including technology development, joint demonstrators and joint contributions to standards. The proposal 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

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 cooperation with the USA and Canada 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 should 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 collaboration with the US and Canada. These tasks cannot be implemented using the budget earmarked for the financial support to third parties.

Beneficiaries should 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 (a minimum of five open calls during the lifetime of the project). They should explore synergies with other research and innovation actions, supported at 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 3 to 9 months.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

eXtended Reality (XR)

Proposals are invited against the following topic(s):

HORIZON-CL4-2022-HUMAN-01-14: eXtended Reality Technologies (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 19.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome: Proposals 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 vehicles 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 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 resilience, 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.

HORIZON-CL4-2022-HUMAN-01-19: eXtended Reality Learning - Engage and Interact (IA)

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

contribution per project	5.00 and 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6-7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries may provide financial support to third parties. The support to third parties can only be provided in the form of grants. The maximum amount to be granted to each third party is EUR 300 000 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.

Expected Outcome: Proposals 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, 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. Proposals will make use of XR technologies to develop and test virtual tools for teaching and learning.

The selected proposal 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 (such as but not limited to 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 should 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.

Call - A HUMAN-CENTRED AND ETHICAL DEVELOPMENT OF DIGITAL AND INDUSTRIAL TECHNOLOGIES 2022

HORIZON-CL4-2022-HUMAN-02

Conditions for the Call

Indicative budget(s)[289]

[289] 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.

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[290]	Number of projects expected to be funded
		2022		
Opening: 16 Jun 2022 Deadline(s): 16 Nov 2022				
HORIZON-CL4-2022-HUMAN-02-01	RIA	16.00	Around 4.00	4
HORIZON-CL4-2022-HUMAN-02-02	RIA	34.50	Around 11.50	3
Overall indicative budget		50.50		

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

Leadership in AI based on trust

Proposals are invited against the following topic(s):

290 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.
Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

HORIZON-CL4-2022-HUMAN-02-01: AI for human empowerment (AI, Data and Robotics Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering a broad range of AI research areas, grants will be awarded to applications not only in order of ranking but at least also to the highest ranked proposal addressing focus 1 (mixed human-AI initiatives) and the highest ranked proposal addressing the focus 2 (hybrid decision-support), provided that the applications attain all thresholds.

Expected Outcome: Proposal results are expected to contribute to at least one of the following expected outcomes:

- Truly mixed human-AI initiatives for human empowerment
- Trustworthy hybrid decision-support systems

Scope: Build the next level of **perception, visualisation, 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.

Innovative and promising approaches are encouraged, including human-in the loop approaches for truly mixed human-AI initiatives combining the best of human and machine knowledge and capabilities, tacit knowledge extraction (to design the next generation AI-driven co-creation and collaboration tools embodied e.g. in industrial/working spaces environments).

Each proposal will focus on one of the two following research objectives, and clearly identify it:

1. 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.

2. 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[291] and other disciplines relevant to stimulate novel research avenues, and eventually improve user-acceptance. Collaborative design and evaluation 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, visualisation, 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.

[291] Social Sciences and Humanities

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 platform[292], 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 4-5 by the end of the project.

This topic implements the co-programmed European Partnership on AI, Data and Robotics.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

HORIZON-CL4-2022-HUMAN-02-02: European Network of AI Excellence Centres: Expanding the European AI lighthouse (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 11.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 34.50 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio and maximise the range of approaches and sectors, grants will be awarded to applications not only in order of ranking but at least also to those that are the highest ranked within the focus "Next generation AI" and the highest ranked in the "Scientific research and technologies prioritised in the latest SRIDA", provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply:

[292] Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

	Beneficiaries may provide financial support to third parties.The support to third parties can only be provided in the form of grants.The maximum amount to be granted to each third party is EUR 60 000.

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

- Scientific progress in AI, addressing major challenges hampering its deployment.
- Establishing a new pillars of the European AI lighthouse[293]
- Reinforcing the leading unified European AI community

Scope: To ensure European open strategic autonomy in critical technology such as AI, 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 community to join forces to address major technical as well as sector- or societal-driven challenges: strengthening excellence, networking, multidisciplinarity, academia-industry synergies.

This initiative contributes to 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. To complement and extend this initiative the proposals should create a network of excellence for the following topics:

1. **Next Generation AI –** covering foundational research and emerging and novel approaches, with a view of improving the technical performances of AI-based systems,

[293] In this section AI is taken in the broad sense and covers AI, Data and Robotics

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.

2. Scientific research and technologies prioritised in the latest SRIDA (Strategic Research, Innovation and Deployment Agenda of the AI, Data and Robotics PPP) , and complementing the previously selected Networks of Excellence centres (either in H2020-ICT48, or the first calls for Networks of Excellence Centres in Horizon Europe).

The selected proposals will maximise the coverage of the portfolio of networks of excellence centres in AI.

Composition of the Networks:

- Proposals should be driven by leading researchers in AI and AI relevant technologies from major excellent AI research centres, and bringing the best scientists across Europe, including also 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 multidisciplinarity and multi-sectorial research approach, while respecting equality and diversity among the attracted talents.

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, with a maximum of 60k€ per third party[294]).

- 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, academia and civil society.

- 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

- provide access to the required resources and infrastructure to support the R&D activities of the action, such as cloud and computing capacity, IoT, robotics equipment, support staff and engineers, where relevant, and the capacity to develop prototypes, pilots, demonstrators, etc.

- 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 reference benchmarks 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.

[294] Maximum amount per third party, received from a given Action, over its entire duration

- 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 platform[295] 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. Openness and interoperability of components are encouraged to develop synergies and cross-fertilization between different approaches and solutions (e.g. through modularity of components or open interfaces)

- 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 and Associated Countries, with particular emphasis on geographical aspect and elimination of gaps between Member States/Associated Countries, as well as addressing existing gender disparities.

- exploit and develop technology enablers, such as methodologies, tools and systems and exploit latest hardware development and data spaces, cloud and HPC resources.

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 can help solving, demonstrating the potential positive impact on the society, economy and environment.

Activities are expected to achieve TRL 4-5 by the end of the project.

Proposals are expected to develop synergies:

- With other Networks of excellence centres in AI funded in H2020 or Horizon Europe, with a view of, all together, create vibrant European network of AI excellence centres. To that end, the activities should integrate with and complement the activities of the H2020-ICT-48 projects. The proposals are expected to dedicate tasks to ensure this coherence.

- With relevant activities in AI, Data and Robotics, primarily in destinations 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.

All proposals are expected to allocate tasks to cohesion activities with the PPP on AI, Data and Robotics and funded actions related to this partnership, including the CSA HORIZON-CL4-2021-HUMAN-01-02.

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295 Initiated under the AI4EU project https://cordis.europa.eu/project/id/825619 and further developed in projects resulting from H2020-ICT-49-2020 call

Background

The selected network(s) of excellence centres will contribute to the larger objective of the European Commission to establish the **European AI lighthouse**.

The AI lighthouse is expected to mobilise the AI community 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. This is essential to reach critical mass and overcome the present fragmentation of AI research in Europe.

The lighthouse will bring together **stakeholders from research, innovation and deployment**, to become a **world reference in AI** that can attract investments and the best talents in the field. The lighthouse will build on key pillars, each of them being a network of excellence centres specialising in a given topic where Europe has the potential to become a global champion.

OTHER ACTIONS NOT SUBJECT TO CALLS FOR PROPOSALS

Grants to identified beneficiaries

Specific conditions applying to each of the following actions: HORIZON-CL4-SSA-SST-MS HORIZON-CL4-SSA-SST-STM-AE HORIZON-CL4-SSA-SST-SB HORIZON-CL4-SSA-SST-SP HORIZON-CL4-SSA-SST-SD	
Admissibility conditions	The page limit of the application is 100 pages per topic/action.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: Some activities, resulting from these actions, 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. **Participation limited to legal entities established in Member States only.** In order to guarantee the protection of the strategic assets, interests, autonomy or security of the EU and its Member States, participation is limited to legal entities fulfilling the following conditions: a. be established in a Member State and their executive management structures be established therein, b. commit to carry out all relevant activities in one or more Member States, and c. be established in a Member State and not be subject to control by a third country or by a third country entity. • For the purpose of this Article, control means the ability to exercise a decisive influence on a legal entity directly or indirectly through one or more intermediate legal entity.

	• For the purpose of this Article, executive management structure means body of a legal entity appointed in accordance with national law, and, where applicable, reporting to the chief executive officer, or any other person having comparable decisional power, which is empowered to establish the legal entity's strategy, objectives and overall direction, and which oversees and monitors management decision-making. **Mandatory use of Copernicus and Galileo/EGNOS data for projects using satellite-based earth observation, positioning, navigation and/or timing data and services** If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Award criteria	The proposed project should provide a coherent contribution to the EUSST development plan as the projects to be awarded in this area are all expected to support the improvement of the current EUSST services or the implementation of new ones.
Legal and financial set-up of the Grant Agreements	**Lower funding rates** The funding rate of the eligible costs is defined in the description of each action. As justified in the Implementing Act related to Space regulation Article 58 §8: the philosophy of EUSST is to use national assets which has been built by Member States in order to tackle national needs. While playing national roles, the data collected by these assets can be used in order to provide EUSST services. **Standard deliverables** Grants award under this topic will have to submit the following deliverable(s): • Metrics and KPI (Key Performance Indicators) description • KPI flash report (to be submitted every quarter) • Security sensitive information assessment report (to be submitted at the beginning, at mid-term and towards the end of the project) • data management plan (to be submitted at the beginning, at mid-term and towards the end of the project)

	• communication plan (to be submitted at beginning of the project) • plan for the dissemination and exploitation of results (to be submitted at the beginning, at mid-term and towards the end of the project). **Unlimited subcontracting** Subcontracting is not restricted to a limited part of the action. **Depreciation and full costs for listed equipment eligible** Purchases of equipment, infrastructure or other assets used for the action must be declared as depreciation costs. Moreover, for the following equipment, infrastructure or other assets purchased specifically for the action (or developed as part of the action tasks): sensors and operational centres building blocks constituting the current and future EUSST architecture, costs may exceptionally be declared as full capitalised costs. **Right to object to transfers or licensing** The granting authority may object to a transfer of ownership or the licensing of results under certain conditions. **Additional information obligation relating to standards** The beneficiaries must inform the granting authority if the results could reasonably be expected to contribute to European or international standards.

1. HORIZON-CL4-SSA-SST-MS - 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-manoeuvrable 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.

<u>Scope:</u>

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:
    - Extended computation of conjunctions and risks;
    - Automatic risk estimation and mitigation measures, (e.g. ground or on-board processes and using AI techniques);
    - Support to satellite Owner / Operator in case of need: localisation of the spacecraft; spacecraft anomalies or on orbit contingencies; post-manoeuvre support in order to check the manoeuvre went as planned, etc.
    - 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).
    - Design of innovative solutions for the detection and characterisation of malfunctioning satellites;

  - 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.

  - Stimulation of the use of removal and disposal techniques through regulatory initiatives;

  - Exploring the implementation of an Active Debris Removal (ADR) and on-orbit servicing (OOS) monitoring service, through attitude and relative orbit characterisation;

  - Design associated to removal/servicing technology demonstration;

  - 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 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Implementation: Research and Innovation Action (RIA)

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 awarded without call for proposals according to Financial Regulation Article 195 (d)

Indicative budget: EUR 8.00 million from the 2022 budget

2. HORIZON-CL4-SSA-SST-STM-AE - 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.

More generally, the reliance on space-based data and services, in particular thanks to the success of Copernicus and Galileo European programmes and the forthcoming connectivity constellation, for our society, economy, security and defence has been rapidly growing. At the same time, the emergence of new type of actors and business models (e.g. mega constellation) increases the number of satellites and debris in orbit. For this reason, space becomes more and more congested, posing a threat to the sustainability and safety of space operations and infrastructures, with a higher risk of collision and of radiofrequency interferences.

The importance of SST / Space Traffic Management (STM) is thus growing, in a context where there is lack of a clear definition at international level and no global regime and system is in place, neither are flight rules and the associated monitoring/enforcement means.

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.
- Raise the main issues and propose relevant answers to questions posed by all those developments in various technical and operational domains based on the outcome of the previous STM coordination and support actions developed under H2020.

- Propose adaptation to the new changes, and solutions for their possible integration into the existing standards, practices and technological means.

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 object identification, for navigation aids and for servicing interfaces.
- Contribution to 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 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Implementation: Research and Innovation Action (RIA)

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 awarded without call for proposals according to Financial Regulation Article 195 (d)

Indicative budget: EUR 6.00 million from the 2022 budget

3. HORIZON-CL4-SSA-SST-SB - 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 etc.) 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 etc.) 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.

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 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Implementation: Research and Innovation Action (RIA)

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 awarded without call for proposals according to Financial Regulation Article 195 (d)

Indicative budget: EUR 6.00 million from the 2022 budget

4. HORIZON-CL4-SSA-SST-SP - 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, innovative wide field optical sensors, 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, improving 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 *HORIZON-CL4-SSA-SST-MS 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.

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 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Implementation: Innovation Action (IA) with a reduced funding rate (45%)

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 awarded without call for proposals according to Financial Regulation Article 195 (d)

Indicative budget: EUR 25.00 million from the 2022 budget

5. HORIZON-CL4-SSA-SST-SD - 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.

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 to protect the EUSST infrastructure.
- 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 and Article 20 of the Horizon Europe Framework Programme and Rules for Participation.

Implementation: Innovation Action (IA)

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 awarded without call for proposals according to Financial Regulation Article 195 (d)

Indicative budget: EUR 7.00 million from the 2022 budget

6. European Startup Nations Standard

European SMEs and startups face several challenges 'on the ground' as they pursue ambitions of securing market opportunities and growing their revenues. Many European countries are already pursuing best practices to help startups address challenges such as making it easier to start-up and expand across borders, streamline visa and residency applications for third country talent, make granting of employee stock options more attractive, promote venture-

building and tech transfer from universities, and increase access to finance for scaling-up. The Startup Nation Standard was announced as a key action in the European Commission's SME Strategy. Subsequently the European Commission together with the MS established an initial set of Startup Nation Standards. The action was launched politically at the March 2021 Digital Day event under the PT EUCO presidency through a declaration calling for commitments from Member States and EEA countries to implement such practices at national levels. In order to regularly monitor progress of countries in achieving the Startup Nations Standards, support is needed for its implementation.

Expected Impact: It is expected to be a catalyst for reform in member states and to drive their delivery of framework conditions adapted to the needs of high growth startups and contribute to making Europe the most attractive Startup and Scaleup continent.

Expected Outcome. The supporting service provider will develop the method, benchmark, ensure broad outreach and communication with startup stakeholders across Europe, oversee tracking and report on progress of Signatory Countries in achieving the Startup Nations standard of excellence.

Scope: The initiative will focus on the set of standards agreed by the country signatories to the Startup Nations Standard political declaration.

This grant will be awarded without a call for proposals according to Article 195 (e) of the Financial Regulation and the relevant provisions of the Horizon Europe Framework Programme and Rules for Participation to the legal entity identified below as it has been agreed by the signatory EU and EEA countries that it will implement the action on their behalf in cooperation with the European Commission.

Funding Rate: 100%

Legal entities:

EUROPE STARTUP NATIONS ALLIANCE, Rua da Emenda 91, ZIP Code – 1200-169 Lisboa, Portugal

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: Third or fourth quarter of 2021

Indicative budget: EUR 1.00 million from the 2021 budget

7. Presidency event (conference) in France: Industrial Technologies 2022

Events of a major strategic nature, which are focused and attract a broad spectrum of stakeholders are important in assessing past activities, identifying policy options and priorities, and planning future actions.

The European Commission will support the organisation of an event (conference) in France in the first half of 2022, in cooperation with the French government, holding the EU Presidency of the European Union at the time.

The conference should cover in particular the twin green and digital transformation of European industry, with a focus on resilience post-Covid. It should focus on how breakthrough technologies and scale up of industrial innovations could influence such twin transition.

It should enhance synergies between research and innovation initiatives launched by the Commission and by the Member States. The proposed content should be balanced, encompassing policy, technological, economic and social elements and points of view. The conference should be open to participants outside the EU. Outreach activities may be included, such as a press programme; activities dedicated to the wider public or schools are particularly encouraged.

To ensure impact, the focus and content of the conference should be well defined and clearly aligned with other Presidency events already undertaken, while reflecting specific regional strengths and needs.

The commitment of the national authorities to support the event, politically as well as financially, is a pre-requisite to submitting a proposal. Proposals should be supported by the competent Minister, evidenced in a letter included in the proposal. In order to ensure high political and strategic relevance, the active involvement of the competent national authorities will be assessed in the evaluation.

In agreement with the Commission services, projects should ensure appropriate flexibility, so as to respond to rapidly changing policy scenarios.

The event is expected to result in: improved visibility of industrial technologies; identification of policy options and priorities via review and assessment of developments, and sharing of information and comparison of points of views; and efficient networking of various stakeholders and support to their activities, e.g. industry, small and medium sized enterprises, businesses, investors, local authorities, non-governmental organisations, trade unions, etc.

Legal entities:

Commissariat à l'Energie Atomique et aux Energies Renouvelables (CEA)

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: First semester of 2022

Indicative budget: EUR 0.10 million from the 2021 budget

8. Presidency event (conference) in Sweden: EuroNanoForum 2023

Events of a major strategic nature, which are focused and attract a broad spectrum of stakeholders are important in assessing past activities, identifying policy options and priorities, and planning future actions.

The European Commission will support the organisation of an event (conference) in the first half of 2023, in cooperation with the Swedish government, holding the EU Presidency of the European Union at the time. The conference should cover an issue of direct relevance to the Cluster 4 (Digital, Industry and Space) of Horizon Europe, in particular industrial technologies focusing on advanced materials and manufacturing and their impact to the Green Deal and the Industrial Strategy.

It should enhance synergies between research and innovation initiatives launched by the Commission and by the Member States. The proposed content should be balanced, encompassing policy, technological, economic and social elements and points of view. The conference should be open to participants outside the EU. Outreach activities may be included, such as a press programme; activities dedicated to the wider public or schools are particularly encouraged.

To ensure impact, the focus and content of the conference should be well defined and clearly aligned with other Presidency events already undertaken, while reflecting the specific strengths and needs of Sweden and its regional links.

The commitment of the national authorities to support the event, politically as well as financially, is a pre-requisite to submitting a proposal. Proposals should be supported by the competent Ministers, evidenced in a letter included in the proposal. In order to ensure high political and strategic relevance, the active involvement of the competent national authorities will be assessed in the evaluation.

In agreement with the Commission services, projects should ensure appropriate flexibility, so as to respond to rapidly changing policy scenarios.

The event is expected to result in: improved visibility of the nanotechnologies and advanced materials areas in Cluster 4; identification of policy options and priorities through a review and assessment of developments; sharing of information and comparison of points of views;

and efficient networking of various stakeholders and support to their activities, e.g. industry, small and medium sized enterprises, businesses, investors, local authorities, non-governmental organisations, trade unions, etc.

Legal entities:

Vinnova, Mäster Samuelsgatan 56, 101 58 Stockholm, Sweden

Form of Funding: Grants not subject to calls for proposals

Type of Action: Grant to identified beneficiary according to Financial Regulation Article 195(e) - Coordination and support action

The general conditions, including admissibility conditions, eligibility conditions, award criteria, evaluation and award procedure, legal and financial set-up for grants, financial and operational capacity and exclusion, and procedure are provided in parts A to G of the General Annexes.

Indicative timetable: First semester of 2023

Indicative budget: EUR 0.10 million from the 2022 budget

9. HORIZON-CL4-QUANTUM-01-SGA - Developing the first large-scale quantum computers (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-HORIZON-CL4-2021-DIGITAL-EMERGING-02-15: 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 3.5 years of the action plan defined in the above 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 HORIZON-CL4-2021-DIGITAL-EMERGING-02-10: Strengthening the quantum software ecosystem for quantum computing platforms), 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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4- HORIZON-CL4-2021-DIGITAL-EMERGING-02-15: Framework Partnership Agreement for developing the first large-scale quantum computers (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this action the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 18.000.000 EUR

Maximum contribution: 20.000.000 EUR

Expected grants: 2

Technology Readiness Level - Technology readiness level expected from completed projects

Activities are expected to start at TRL 4-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such

programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or securityThe guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:

a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;

b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;

c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

Indicative timetable: Second/Third quarter of 2022

Indicative budget: EUR 40.00 million from the 2022 budget[296]

10. HORIZON-CL4-QUANTUM-02-SGA - Developing large scale quantum simulation platform technologies (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-2021-DIGITAL-EMERGING-02-17: Framework Partnership Agreement for developing large

[296] Of which EUR 34.60 million from the 'NGEU' Fund Source.

scale quantum simulation platform technologies (FPA), each of the selected consortia will be invited to submit a proposal that will implement the first 3.5 years of the action plan defined in the above 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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-17: Framework Partnership Agreement for developing large scale quantum simulation platform technologies (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 16.600.000 EUR

Maximum contribution: 16.600.000 EUR

Expected grants: 1

Technology Readiness Level - Technology readiness level expected from completed projects

Activities are expected to start at TRL 4-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[297]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

Indicative timetable: Second/Third quarter of 2022

[297] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Indicative budget: EUR 16.60 million from the 2022 budget

11. HORIZON-CL4-QUANTUM-03-SGA - Building the Quantum Internet (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-DIGITAL-EMERGING-2021-02-19: Framework Partnership Agreements in Quantum Communications (FPA), the selected consortium will be invited to submit a proposal that will implement the first 3.5 years 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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-DIGITAL-EMERGING-2021-02-19: Framework Partnership Agreements in Quantum Communications (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 24.000.000 EUR

Maximum contribution: 24.000.000 EUR

Expected grants: 1

Technology Readiness Level - Technology readiness level expected from completed projects

Activities are expected to start at TRL 2-4 and achieve TRL 4-6 by the end of the project – see General Annex B.

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[298]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

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298 The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Indicative timetable: Second/Third quarter of 2022

Indicative budget: EUR 24.00 million from the 2022 budget

12. HORIZON-CL4-QUANTUM-04-SGA - Quantum encryption and future quantum network technologies (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-2021-DIGITAL-EMERGING-02-19: Framework Partnership Agreements in Quantum Communications (FPA), the selected consortium will be invited to submit a proposal that will implement the first 3.5 years 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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-19: Framework Partnership Agreements in Quantum Communications (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 25.000.000 EUR

Maximum contribution: 25.000.000 EUR

Expected grants: 1

Technology Readiness Level - Technology readiness level expected from completed projects

Activities are expected to start at TRL 4-5 and achieve TRL 6-7 by the end of the project – see General Annex B.

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

For the duly justified and exceptional reasons listed in the paragraph above, in order to guarantee the protection of the strategic interests of the Union and its Member States, entities established in an eligible country listed above, but which are directly or indirectly controlled by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[299]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

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[299] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

Indicative timetable: Second/Third quarter of 2022

Indicative budget: EUR 25.00 million from the 2022 budget

13. HORIZON-CL4-QUANTUM-05-SGA - Supporting open testing and experimentation for quantum technologies in Europe (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-2021-DIGITAL-EMERGING-02-22: 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 3.5 years 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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 19.000.000 EUR

Maximum contribution: 19.000.000 EUR

Expected grants: 1

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

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[300] The guarantees shall in particular substantiate that, for the purpose of the action, measures are in place to ensure that:
a) control over the applicant legal entity is not exercised in a manner that retrains or restricts its ability to carry out the action and to deliver results, that imposes restrictions concerning its infrastructure, facilities, assets, resources, intellectual property or know-how needed for the purpose of the action, or that undermines its capabilities and standards necessary to carry out the action;
b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

Indicative timetable: Second/Third quarter of 2022

Indicative budget: EUR 19.00 million from the 2022 budget

14. HORIZON-CL4-QUANTUM-06-SGA - Supporting experimental production capabilities for quantum technologies in Europe (SGA)

Objective of the SGA

Within the Framework Partnership Agreement (FPA) awarded under topic HORIZON-CL4-2021-DIGITAL-EMERGING-02-22: 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 3.5 years 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.

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c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

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 Europe; for example, through the involvement of Widening Countries.

HORIZON-CL4-2021-DIGITAL-EMERGING-02-22: Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA) with identified beneficiary and specific grants awarded to identified beneficiary for Research and Innovation Action under the Framework Partnership Agreement.

The standard evaluation criteria, thresholds, weighting for award criteria and the maximum rate of co-financing for this type of action are provided in parts C and E of the General Annexes.

In this topic the integration of the gender dimension (sex and gender analysis) in research and innovation content is not a mandatory requirement.

Funding rate: 100%

Minimum contribution: 19.000.000 EUR

Maximum contribution: 19.000.000 EUR

Expected grants: 1

Eligibility conditions - Participation limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom

In order to achieve the expected outcomes, and safeguard the Union's strategic assets, interests, autonomy, and security, it is important to avoid a situation of technological dependency on a non-EU source, in a global context that requires the EU to take action to build on its strengths, and to carefully assess and address any strategic weaknesses, vulnerabilities and high-risk dependencies which put at risk the attainment of its ambitions. For this reason, participation is limited to legal entities established in Member States, Iceland, Norway, Israel and the United Kingdom. The eligibility of entities established in the UK to participate is conditional upon reciprocity of access to equivalent UK programmes for entities established in Member States, which will be assessed by the Commission as soon as such programmes are established and in any event before the signature of the grant agreements. Should the UK not open the participation in its relevant programmes to entities established in Member States, this condition would not be met and entities established in the UK will not be eligible to participate in this topic.

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by a non-eligible country or by a non-eligible country entity, may not participate in the action unless it can be demonstrated, by means of guarantees provided by their eligible country of establishment, that their participation to the action would not negatively impact the Union's strategic, assets, interests, autonomy, or security[301]

Form of Funding: Grants not subject to calls for proposals

Type of Action: Specific grant agreement awarded without call for proposals in relation to a Framework Partnership Agreement

Indicative timetable: Second/Third quarter of 2022

Indicative budget: EUR 19.00 million from the 2022 budget

Public procurement

1. Monitoring and assessment of industrial investments in R&D&I and technologies, technology and market assessment for enabling and emerging technologies and green technologies, in relation to the Green Deal and Sustainable Development Goals (SDGs)

Expected Impact:

The objective of this action is the provision of methods, indicators, data and analysis assessing industry's R&D&I investments to achieve 'Green Deal' and other Commission priorities and European policy goals, assessment of the state of play in industrial innovation efforts in the context of participation in global R&I networks and strategic value chains and eco-systems. The action will contribute to building a monitoring and assessment facility on industrial R&D&I investment data which allows a more systematic, methodology based and continuous monitoring of industrial R&I agendas and investments relevant to achieve the Green Deal goals.

The expected 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, as well as helping to improve reporting in the Competitiveness Progress Report as required by the Energy Union Governance Regulation. Data and analyses

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b) access by a non-eligible country or by a non-eligible country entity to sensitive information relating to the action is prevented; and the employees or other persons involved in the action have a national security clearance issued by an eligible country, where appropriate;
c) ownership of the intellectual property arising from, and the results of, the action remain within the recipient during and after completion of the action, are not subject to control or restrictions by non-eligible countries or non-eligible country entity, and are not exported outside the eligible countries, nor is access to them from outside the eligible countries granted, without the approval of the eligible country in which the legal entity is established.

should support policy development and monitoring and underpin a stronger role of R&I and technologies in EU industrial policy, environmental and climate policy, external relations, international cooperative research, trade negotiations, FDI, etc. in view of increasing EU industries' competitiveness in the areas of green and other technologies.

Scope:

This action will assess the amount and quality of R&D&I that the industry is investing in green technologies and markets, and other critical industries, addressing environmental, competitiveness and inclusiveness goals. The activities will include in-depth analysis of the industries providing and using green and other technologies, R&I investments, take up, use and provision of technologies and related systems in innovation networks, value chains and eco-systems. The activities will also include, for example, building synthetic indicators to measure the "fitness" and industries' overtime impact respectively on SDGs and on economic and technological competitiveness, and in general the adoption of sustainable technologies and solutions by industry sectors and eco- systems.

The results and facility should be complementary to the EU 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. This action should extend the analysis to industries beyond the top actors, and add a number of specific indicators and analyses allowing more and systematic insight into industrial innovation and market dynamics and put this in relation with evolving policy needs and the impact of public support.

Data sources could be IP, balance sheets, annual reports, cutting-edge industrial experts and other documentation and any other sources to assess industry's and value chains' economic and technological fitness, market share and other related data, and relevant indicators. Insights into the conditions for the needed industrial transformations and drivers and barriers will be of special interest. Possible data types include also the 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 could also be developed for other technology areas. As the green and digital transitions are interlinked and rely on new and key enabling technologies, also technological sovereignty issues deserve attention. Data and conclusions should address different levels - region/country, sectors/eco-systems, companies.

Focus on specific technologies or eco-systems should be in line with Commission priorities, the development common industrial technology roadmaps as set out in the new ERA (European Research Area) Strategy, and emerging needs, taking into account partnerships, priority areas in the 'Destinations' in Horizon Europe and relevant activities and results under Horizon 2020.

Activities in this action will be complementary to the work done under the GLORIA Administrative Agreements with the JRC and build on previous actions on data and analyses in Horizon 2020 (e.g. Green Deal Call 2020).

Duration: 36 months

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q2-Q4, 2022

Indicative budget: EUR 4.00 million from the 2022 budget

2. Simulation approaches for complex socio-economic systems

Expected Outcomes:

Provide the Commission with a granular social simulation tool to assess the impact of policies on 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 hypotheses. The artificially created environment of multi-agent simulation tools can and fill this gap. The Commission will benefit from this tool for the ex-ante impact assessment and ex-post evaluation of policies related to individual rights in strategic market and non-market settings.

Duration: 18 months

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q3 2021

Indicative budget: EUR 1.00 million from the 2021 budget

Form of Funding: Procurement

Type of Action: Public procurement

Indicative budget: EUR 1.00 million from the 2021 budget

3. 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.

The upstream R&D actions in 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: Procurement

Type of Action: Public procurement

Indicative timetable: Q3-Q4 2021

Indicative budget: EUR 1.30 million from the 2021 budget and EUR 5.00 million from the 2022 budget

4. Support European "New Space" entrepreneurship through CASSINI Space Entrepreneurship Initiative 2021-2027

CASSINI Business Accelerator

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.

Amount: The call for tender for Business Accelerator will be made in 2021 and the budgetary commitment of EUR 8.50 million 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.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative budget: EUR 8.50 million from the 2021 budget

5. Digital Assembly Events 2022 and 2023

DG CONNECT is organising the Digital Assembly Events 2022 and 2023. 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 2rd calendar quarter of 2022 and in the 2nd calendar quarter of 2023. The call for tenders are expected to be launched on the 1st and 2nd calendar quarter of 2022 and 2023.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q2 2022 and Q2 2023

Indicative budget: EUR 1.00 million from the 2022 budget

6. Digital 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 Digital proposers' day (2022). DG CONNECT plans to conclude service contracts in 2022, and also use existing Framework Contracts for this purpose. Indicative budget in 2022: EUR 1.5 million.

- Other events and publications (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. Indicative budget in 2021: EUR 1 million. Indicative budget in 2022: EUR 2.2 million.

- 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.

- 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 for Studies and Policy support in 2021: EUR 3 million. Indicative budget in 2022: EUR 4 million.

Details will be provided in the texts of these calls for tender.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative budget: EUR 4.00 million from the 2021 budget and EUR 7.70 million from the 2022 budget

7. Space conferences, outreach, studies and other activities

It is envisaged to conduct public procurement activities for the organisation of events (conferences, workshops or seminars) for the implementation of the European Space Policy, European R&D research agendas related to Horizon Europe.

Support may be given to the organisation of conferences and information events to strengthen wider participation in the programme (including that of third countries), and to disseminate results of European research in the Space sector. Cooperation with the presidencies of the Council of the European Union is envisaged.

Furthermore, procurement will be necessary of actions such as studies, preparation of roadmaps to underpin planning or actions to evaluate the outcomes of R&D actions.

Activities may include surveys as appropriate implemented through public procurement, and/or appointing (groups of) independent experts. This limited number of contracts may be implemented on the basis of framework contracts, in order to further ensure that the Commission is provided with appropriate and timely analyses, which in turn will facilitate the proper integration of policy studies into the preparation of new policy initiatives.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative budget: EUR 0.50 million from the 2021 budget and EUR 1.20 million from the 2022 budget

8. Procurement for input to development of Industrial technology roadmaps for the Green Deal, EU industry sustainability, competitiveness and resilience

Expected Impact:

Intended results of the action will be a number of discussion papers and assessments on the evidence on the state of play in R&I and possibilities to strengthen policy action for EU development of key green techs and other strategically important industries addressing environmental, competitiveness and inclusiveness targets.

Overall impact is to facilitate the Commission's discussion with Member States, industry and other stakeholders in view of helping to make better use of R&I to strengthen EU industrial ecosystems and Industrial alliances.,

Scope:

A climate-neutral economy 2050 and open technological autonomy require targeted R&I action with a common vision. Relevant Horizon partnerships and the European Innovation

Council provide a basis to boost the development of breakthrough technologies, which can help EU industry achieving these goals.

Discussion with Member States, industry and other stakeholders to drive relevant R&I action must be based upon evidence. Inputs produced under this action shall help informing this development through discussion documents based upon Commission services' work, complemented by relevant evidence from other sources, and through assessment and enrichment of results and their feeding back into the further development of policy recommendations.

Duration: 24 months

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q4 2021

Indicative budget: EUR 0.30 million from the 2021 budget and EUR 0.70 million from the 2022 budget

9. Update of the Material System Analyses (MSA)

The Material System Analysis (MSA) data sets investigate the flows of materials through the EU-27 economy in terms of entry into the EU, flows through the economy, stock accumulation, incl. end-of-life management. They contain key material specific data and information. (3) monitoring of the circular economy; as well as providing useful information for other activities. The MSAs support the RM policy development, and in the mid-term provide a basis for developing sound sustainable resource management strategies. They also contain useful information supporting other activities, such as the monitoring of the circular economy. The first study on the MSA of 28 materials was published in 2015, and subsequent studies have been performed for bulk metals and materials in the public and political focus.

This action will entail collecting new data and information for the materials covered up to 2018 and updating their MSA.

Duration: 12 months

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q4 2021

Indicative budget: EUR 0.50 million from the 2021 budget

10. Raw Materials events

It is envisaged to procure activities for the organisation of events (conferences, workshops or seminars), including the Raw Materials Week through Framework Contracts before the end of 2022.

DG GROW is organising the Raw Materials Week in the fourth calendar quarter of 2022, covering set of events including the High Level Conference of the European Innovation Partnership (EIP) on Raw Materials.

Form of Funding: Procurement

Type of Action: Public procurement

Indicative timetable: Q4 2022

Indicative budget: EUR 0.60 million from the 2022 budget

Other budget implementation instruments

1. Use of individual experts to advise on EU research and innovation policy

This action will support the provision of independent expertise for advising and assisting the Commission services with the implementation, evaluation and design of EU research and innovation policies. Individual experts will work in the following policy areas:

- Industrial Technologies including manufacturing and processing technologies, advanced materials, emerging technologies
- Sustainability and Sustainable Development Goals
- Technology sovereignty
- Industry driven Research infrastructures and pilot lines
- Technology roadmaps and exploitation aspects
- Regulatory constraints
- Review and update of indices

The tasks of individual experts would include:

Analysis of the contribution of a portfolio of projects funded under H2020 or previous research programmes to the relevant EU policy objectives; analysis of the state-of-the-art at international level; investigation of deployment options for the developed knowledge and innovation; assisting for setting-up a research and innovation strategy for selected domains; advise the Commission on outstanding knowledge creation and promising technologies covered by European funded projects and propose policy recommendations and options with a

view to reinforce the Commission capacity to elaborate evidence-based and science-proof policy proposals.

Targeted analysis of data and indices

The advice provided by each individual expert will focus on specific areas and policy relevant projects' results as well as data, information and concepts related to technology roadmaps and policy monitoring e.g. through indices.

The individual experts' tasks will include attending bilateral meetings with Commission services and remote drafting and possible preparatory work. The experts will be highly qualified and specialised, and will be selected on the basis of objective criteria, following an open call for expressions of interest. A special allowance of EUR 450/day will be paid to the expert appointed in its personal capacity who acts independently and in the public interest.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative timetable: 2021 and 2022

Indicative budget: EUR 0.20 million from the 2021 budget and EUR 0.30 million from the 2022 budget

2. Use of individual experts to support the raw materials policy

This action will support the use of appointed individual independent experts for assisting the Commission with advising and assisting the Commission services with the implementation and design of the EU Raw materials policy, and reinforcing the Commission capacity to elaborate evidence-based raw materials policy and the industrial transition to a climate-neutral Europe. Individual experts will work on quantitative analysis of the criticality of individual raw materials based on the EU methodology; critical raw materials supply and demand; future raw materials trends and innovation potential; and technology, infrastructure and raw materials requirements for the industrial transition.

The tasks of individual experts would include attending bilateral meetings with Commission services, remote analysis, drafting and preparatory work. The experts will be highly qualified and specialised, and will be selected on the basis of objective criteria, following an open call for expressions of interest. A special allowance of EUR 450/day will be paid to the expert appointed in its personal capacity who acts independently and in the public interest.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative timetable: Q4 2021

Indicative budget: EUR 0.40 million from the 2021 budget

3. Project monitoring

This action will support the use of appointed independent experts by HADEA for the monitoring of running projects (Space), where appropriate.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative budget: EUR 0.50 million from the 2021 budget and EUR 1.00 million from the 2022 budget

4. Project monitoring

This action will support the use of appointed independent experts by HADEA for the monitoring of running projects, where appropriate.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative budget: EUR 1.05 million from the 2021 budget and EUR 2.45 million from the 2022 budget

5. Project monitoring and use of individual experts to advise on EU digital policies

This action will support the use of appointed independent experts by CNECT and HADEA for the monitoring of actions (grant agreement, grant decision, public procurement actions, financial instruments) and where appropriate include ethics checks.

This action will support the provision of independent expertise for advising and assisting the Commission services with the implementation, evaluation and design of the EU digital policies, including as regards digital sovereignty, technology roadmaps and exploitation aspects, regulatory constraints.

The tasks of individual experts would include the analysis of the contribution of a portfolio of projects funded under H2020 or previous research programmes to the relevant EU policy objectives; analysis of the state-of-the-art at international level; investigation of deployment options for the developed knowledge and innovation; assisting for setting-up a research and innovation strategy for selected domains; advise the Commission on outstanding knowledge creation and promising technologies covered by European funded projects and propose policy recommendations and options with a view to reinforce the Commission capacity to elaborate evidence-based and science-proof policy proposals. The advice provided by each individual expert will focus on specific areas and policy relevant projects' results as well as data, information and concepts related to technology roadmaps and policy monitoring.

The tasks of individual experts will include attending bilateral meetings with Commission services, remote analysis, drafting and preparatory work. The experts will be highly qualified

and specialised, and will be selected on the basis of objective criteria, following an open call for expressions of interest. A special allowance of EUR 450/day will be paid to the expert appointed in its personal capacity who acts independently and in the public interest.

Form of Funding: Other budget implementation instruments

Type of Action: Expert contract action

Indicative budget: EUR 1.90 million from the 2021 budget and EUR 4.00 million from the 2022 budget

Scientific and technical services by the Joint Research Centre

1. Scientific and technical services by the Joint Research Centre

GLORIA - Global Research and Innovation Analysis - Extended Industrial R&D&I Investment Monitoring and Assessment Facility

The objective is to continue the 15-year collaboration of the monitoring of top R&D players (Scoreboards) and build an extended facility around it, expanding the Commission's internal analytical capacities towards the priority goals. This will allow better understanding how the concept of "corporate R&I for sustainable competitiveness" can contribute to the Prosperity policy goal. For this, the EU Industrial R&D Investment Scoreboards will be developed towards a more meaningful tool regarding the directionality of corporate R&D&I.

Scope: The previous monitoring activities already provide a number of indicators on corporate R&D intensity, type of invested technologies and economic strength. The objective of this action is to continue adding indicators and dedicated analyses on investments in R&D&I, technologies and assets, targeting specifically the monitoring of industries that are critical to current policy priorities, such as green or advanced manufacturing technologies.

Duration: 48 months

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: Q4 2021

Indicative budget: EUR 3.50 million from the 2021 budget

2. Criteria for Safe and Sustainable-by-Design advanced materials and chemicals

The objective is to develop a general framework for Safe and Sustainable-by-Design (SSbD) criteria definition and apply it through selected case studies of advanced materials and chemicals.

Scope: Dimensions of Safe and Sustainable-by-Design criteria for advanced materials and chemicals will be defined at horizontal level including an overview of methods and standards

available to measure them. The basis for the definition will be, among others, a review of the literature and of existing initiatives as well as feedback from stakeholders e.g. via a stakeholder meeting. Also current legislation (e.g. REACH, CLP, industrial emissions directive) will be scrutinised enabling the addition of dimensions that might not be covered by existing EU policies. A methodology to define SSbD criteria will also be developed, taking into account the whole life cycle of the chemical/material/product , which can then be tailored for developing specific SSbD criteria. Case studies will test the proposed criteria on advanced materials/chemicals/products. Developers, scientists and regulators will be consulted to provide feedback on developed criteria. The target is to obtain a methodology that is in line with the advancement of other, parallel, related actions foreseen in the Chemicals Strategy for Sustainability.

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: Q2 2021

Indicative budget: EUR 0.60 million from the 2021 budget

3. Support for the Strategic Implementation Plan of the European Innovation Partnership on Raw Materials and the Action Plan on Critical Raw Materials

Objective: To continue the collaboration with the JRC on various aspects of raw materials policy, such as framework conditions and potential supply of primary raw materials, sourcing from third countries, availability and mapping of secondary raw materials, and monitoring/reporting on these and other aspects in the Raw Materials Scoreboard.

Duration: 24 months

Form of Funding: Direct action grants

Type of Action: Provision of technical/scientific services by the Joint Research Centre

Indicative timetable: Q1 2022

Indicative budget: EUR 0.60 million from the 2022 budget

Indirectly managed actions

1. Indirectly managed actions delegated to ESA

The following four actions will be implemented by the European Space Agency (ESA) under a contribution agreement between the Commission and the agency.

1.1. EGNSS Evolution: Technology and infrastructure-related R&D activities

Actions under this area will address upstream R&D activities. They 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.

Indicative budget for this action: EUR 42.70 million from the 2021 budget and EUR 44.00 million from the 2022 budget

1.2. HORIZON-CL4-SSA-SWENEO - Space Weather and Near Earth Objects

a) Space Weather

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 under this area will be delegated to ESA and will deal with "development of certain technology elements for promising precursor services" and "exploratory space weather payloads studies". They shall be complementarity to Space Weather services developed through the Space Situational Awareness component of the EU Space Programme.

b) Near Earth Objects

Our knowledge of the physical characteristics of the NEO population is limited. And there is a need of continuously investigate and share the physical and dynamical properties of the NEO population as a whole, either through ground-based observations or through missions to asteroids (e.g. close proximity operations to NEOs or mitigation demonstration). It is necessary to have a number of specific technologies and instruments readily available to further strengthening the science return of a mission.

Research and innovation activities under this area will be delegated to ESA and will study "precursor services / European hot-redundant Minor Planet Centre backup" and "Increase networking of MS assets".

Indicative budget for this action: EUR 4.00 million from the 2022 budget

1.3. GOVSATCOM Technology Development and implementation of system innovative features

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.

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).

Indicative budget for this action: EUR 8.00 million from the 2021 budget

1.4. CASSINI 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 IOD/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 scope of the activities may include 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, including the QKD payload of Eagle 1[302], 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 should support the European launcher exploitation policy, therefore relying as far as possible on EU manufactured launcher solutions launched from the EU 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).

Concerning the QKD payload of Eagle 1, ESA shall ensure that critical components are based on EU technologies.

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302 In the frame of this IOD/IOV service, to accelerate the implementation of the EU-wide quantum communication infrastructure (EuroQCI), the Union will support the ESA SAGA initiative by providing the aggregation of for the QKD payload of Eagle 1 on the satellite platform, the related launch services and initial in-orbit testing.

Indicative budget for this action: EUR 24.00 million from the 2021 budget and EUR 5.00 million from the 2022 budget

Legal entities:

European Space Agency (ESA)

Form of Funding: Indirectly managed actions

Type of Action: Indirectly managed action

Indicative budget: EUR 74.70 million from the 2021 budget and EUR 53.00 million from the 2022 budget

2. Indirectly managed actions delegated to EUSPA

The following six activities will be implemented by the European Union Space programme Agency - EUSPA (the former European GNSS Agency - GSA), under a contribution agreement between the Commission and the agency.

2.1. EIC Horizon and CASSINI Prize for digital space applications

The specific rules of the contest ("the challenge") will be published in 2021.

Expected results: The prize will be awarded to one or several best data-driven marine or maritime digital application(s) meeting the criteria of the contest. 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 detection and monitoring of ocean pollution, monitoring and forecasting of marine and coastal environments, marine resources, offshore activities. 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, as defined in the challenge, related to the detection and monitoring of ocean pollution, monitoring and forecasting of marine and coastal environments, marine resources, and offshore activities.

- 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: Only SMEs are eligible to participate.

The reward (budget): The indicative budget for the prize is EUR 3.4 million from the 2022 budget, to be awarded to one/several winning contestant(s).

Indicative timetable of contest(s):

Stages	Date and time or indicative period
Opening of the contest	Q3 2021
Deadline for submission of application	Q2-Q3 2022
Award of the prize	Q3-Q4 2022

Type of Action: Inducement Prize

2.2. EIC Horizon and CASSINI Prize for space technology products and services

The specific rules of the contest ("the challenge") will be published in 2021.

Expected results: The prize will be awarded to one or several best solution(s) for implementing an EU developed and manufactured fully or partially reusable microlauncher solutions using green (environmentally sustainable) propulsion and 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.

The reward (budget): The indicative budget for the prize is EUR 5.00 million from the 2022 budget, to be awarded to one/several winning contestant(s).

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 the rules of contest will:

a. stipulate that a proposal may be rejected for security reasons;

b. provide further details on the development and deployment of the solution.

Indicative timetable of contest(s):

Stages	Date and time or indicative period
Opening of the contest	Q3 2021
Deadline for submission of application	Q2-Q3 2022
Award of the prize	Q3-Q4 2022

Type of Action: Inducement Prize

2.3. Support European "New Space" entrepreneurship through CASSINI Space Entrepreneurship Initiative 2021-2027 - Hackathons & Mentoring

Implementation: the action will be implemented by the Commission through a specific contract 2021-2023 concluded in 2020 under the existing Copernicus Framework Contract with the consortium led by Verhaert New Products & Services NV and SpaceTec Partners. The task will extended in 2022 for the activation of the two-year extension of the contract.

Amount: The contract for Year 1 of Hackathons & Mentoring will be a commitment of EUR 1.2 million on the 2020 Galileo Programme budget, and to activate the extension for Year 2+3 a commitment of EUR 2.40 million will be made on the **2022 budget of** Horizon Europe.

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.

Type of Action: Public procurement

Indicative budget: EUR 2.40 million from the 2022 budget

2.4. Innovation activities for improved EGNSS operation and service provision

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.

Indicative budget for this action: EUR 5.00 million from the 2021 budget

2.5. Development of applications for Galileo, EGNOS and Copernicus

Actions under this area will address downstream R&D activities in the form of calls to proposals to be launched by the European Union Space Programme Agency (EUSPA) in accordance with the specification included in Appendix below.

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 markets with a long lead-time (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, civil security, migration and agriculture. They and can bring, with 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 the creation of a wealth of new and innovative applications and services. The use of Copernicus and Galileo/EGNOS for the EOSC and DestinE initiatives should equally be taken into account and promoted.

Indicative budget for this action: EUR 32.60 million from the 2021 budget and EUR 48.10 million from the 2022 budget

2.6 Tender evaluation, project monitoring and audits (EGNSS/Copernicus downstream)

This action will support the use of appointed independent experts by EUSPA for the monitoring of running projects, tender evaluation and audits where appropriate.

Indicative budget for this action: EUR 0.50 million from the 2021 budget and EUR 1.00 million from the 2022 budget

Legal entities:

European Union Space Programme Agency - EUSPA (formerly GSA)

Form of Funding: Indirectly managed actions

Type of Action: Indirectly managed action

Indicative budget: EUR 38.10 million from the 2021 budget[303] and EUR 59.90 million from the 2022 budget[304]

APPENDIX TO ACTION 2.5
Specification of the two calls to be launched by EUSPA under indirect management during 2021 and 2022

The following information is provided for information purposes.

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2021 - APPLICATIONS

HORIZON-EUSPA-2021-SPACE-02

Conditions for the Call

Indicative budget(s)[305]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[306]	Number of projects expected to be funded
		2021		
Opening: 2021 (indicative) Deadline(s): 2021-2022 (indicative)				
HORIZON-EUSPA-2021-SPACE-02-51	IA	14.00 [307]	2.00 to 3.00	5

303 Of which EUR 19.72 million from the 'NGEU' Fund Source.
304 Of which EUR 32.69 million from the 'NGEU' Fund Source.
305 The Agency 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 Agendcy 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.
306 Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
307 Of which EUR 8.47 million from the 'NGEU' Fund Source.

HORIZON-EUSPA-2021-SPACE-02-52	IA	9.30 [308]	2.00 to 3.00	3
HORIZON-EUSPA-2021-SPACE-02-53	IA	9.30 [309]	2.00 to 3.00	3
Overall indicative budget		32.60		

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

This call and resulting actions will be implemented under indirect management by the European Union Space programme Agency - EUSPA (the former European GNSS Agency - GSA), subject to the conclusion of a contribution agreement with the Commission.

Development of applications from the EU space programme components

Proposals are invited against the following topic(s):

HORIZON-EUSPA-2021-SPACE-02-51: EGNSS and Copernicus applications fostering the European Green deal

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

308 Of which EUR 5.63 million from the 'NGEU' Fund Source.
309 Of which EUR 5.63 million from the 'NGEU' Fund Source.

contribution per project	2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL7-9 by the end of the project – see General Annex B.

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 deal[310]. These solutions can play a major role in the transformation of the EUs economy into a climate-neutral economy by 2050, as well as support environmental protection, maintaining biodiversity, etc.

Uptake of Copernicus services and/or Galileo's specific features and differentiators in areas such as zero-pollution, EU methane strategy, clear 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 should focus on the development of innovative EGNSS and Copernicus applications that support the Green Deal objectives and its related policies and they can be submitted in any of the following areas:

- **Increasing the EU's climate ambition for 2030 and 2050:** 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 as well as natural catastrophes as pollution sources.

- **Supplying clean, affordable and secure energy**: EGNSS and/or Copernicus based solutions which support the supply of clean, affordable and secure renewable energy.

- **Mitigating natural hazards:**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 and impact monitoring of new sustainable mobility services and which reduce congestion, emissions and pollution especially in urban areas, while keeping costs at an efficient/reasonable level. Examples of emerging applications include automated and connected multimodal transport, public transport, mobility as a service, autonomous driving, IoT solutions for efficient mobility, road maintenance, air quality monitoring and forecasting.

[310] COM (2019) 640 of 11 December 2019

- **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, 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 and valorisation of the "made in Europe". Precision or digital EGNSS farming solutions, which reduce significantly the use of chemical pesticides and fertilisers and help saving water for irrigation. Innovative EGNSS and/or Copernicus based tools that support the digitisation of post-2020 Common Agricultural Policy or other agri-environmental policies.

- **Preserving and restoring ecosystems and biodiversity.** EGNSS and/or Copernicus based solutions which enhance biodiversity monitoring and enable data-driven decision tools for policymakers, to stop biodiversity loss and support the EU nature restoration plan. Examples of emerging applications include monitoring and detection of actions which are threatening the functionality of the ecosystem.

The solutions developed for all areas should leverage the Copernicus data or core services products including Copernicus contributing missions 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.

The developed applications should have a clearly defined commercial potential and should respond to well identified user needs. The developed solution is expected achieve TRL7-9 by the end of the project

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, or outreach to, 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 is compulsory and must 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.

Proposals under this topic should exploit synergies and be complementary to national activities and activities funded by ESA.

Applicants are welcome to use the European space data infrastructures, e g. Galileo Service Centre, EGNOS Data Access Service (EDAS) and the EGNOS user support facilities (ASQF).

Applicants are advised to exploit all possible synergies with other specific actions related to the European Green Deal and funded under the work programme of Cluster 5 “Climate, Energy and Mobility” and of Cluster 6 'Food, Bioeconomy, Natural Resources, Agriculture and Environment'.

HORIZON-EUSPA-2021-SPACE-02-52: EGNSS applications for Safety and Crisis management

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.30 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL7-9 by the end of the project – see General Annex B.

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-based solutions addressing safety concerns, to support the implementation of EU policy priorities relating to the safety of citizens, improved disaster risk management, , better security and resilience of infrastructure and vital societal functions, cybersecurity and crisis management.
- Development of innovative EGNSS-based solutions complementing the products delivered by the Emergency Management and Security Services of Copernicus.

- Awareness raising on the benefits of using EGNSS and Copernicus for emergency disaster risk management, and EGNSS for timing and synchronisation for critical infrastructures.

Scope: Proposals may be submitted in any of the following areas:

- **Improved emergency disaster risk management and societal resilience**. EGNSS solutions for critical services related to detection, preparedness, response, recovery and mitigation of emergencies and disasters, introducing synergies between satellite navigation, earth observation and communications. In particular, the synergies with the Copernicus Emergency Response Service, which is already operational, should be exploited. 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 working. Further promising areas include mapping and high accuracy navigation for response and recovery, more intelligent and accurate distress beacons for Save and Rescue, drone and robot operations for disaster response, GNSS/Copernicus-based earthquake early warning systems, and 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 on 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 Centre 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 should exploit EGNSS differentiators such as Galileo Open Service multi-frequency, 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 should have a clearly defined commercial potential and should respond to user needs. The solution developed is expected to achieve TRL7-9 by the end of the project.

Proposals should deliver new innovative applications, with commercial impact and a clear market uptake. Standardisation of new technologies is also in the scope of the topic and might be considered by the applicant. 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, or outreach to, 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 is compulsory and must be provided as part of the proposal, to demonstrate the user need and sustainability of the project.
- The involvement of public authorities in the safety critical domain may be foreseen, to attract public authorities as launching customer in case of successful projects.

Applicants are advised to exploit all possible synergies with other security specific actions funded under the work programme of Cluster 3 "Civil security for society" and funded under the work programme of Cluster 5 "Climate, Energy and Mobility" (e.g. Aviation safety topic "More resilient aircraft and survivability).

Proposals under this topic should exploit synergies and be complementary to national activities and activities funded by ESA.

Applicants are welcome to use the European space data infrastructures, e g. Galileo Service Centre, EGNOS Data Access Service (EDAS) and the EGNOS user support facilities (ASQF).

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-EUSPA-2021-SPACE-02-53: EGNSS applications for the Digital Age

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.30 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL7-9 by the end of the project – see General Annex B.

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

- Foster the adoption of EGNSS in mass markets and professional 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 and security, 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 features or which leverage the availability of GNSS raw measurements in smartphones.
- **mHealth-solutions for 'silver economy', robotics.** With the ageing population growing fast in the EU, governments will be increasingly challenged to meet 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 greater performance thanks to the optimisation of multiple sensors. Proposals should explore synergies between EGNSS and Artificial Intelligence, 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 should 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. The** sharing economy covers many different sectors. It is rapidly emerging across Europe. Within this trend, GNSS is a key technology for all services requiring geographic information. Newly developed EGNSS solutions in the field of logistics, mobility services, and food industry should capitalise on the 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.

The developed applications should have a clearly defined commercial potential and should respond to user needs. Standardisation of new technologies is also in the scope of the topic and might be considered by the applicant. The solution developed is expected to achieve TRL7-9 by the end of the project.

Proposals should deliver new innovative applications, with commercial and social benefits, impact and a clear market uptake. The standardisation of new technologies is also in the scope of the topic and might be considered by the applicant. 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, or outreach to,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 iscompulsory and must 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.

Applicants are advised to exploit all possible synergies with other security specific actions funded under the work programme of Cluster 1 “Health”, other parts of Cluster 4 “Digital, Industry and Space”, and Cluster 5 “Climate, Energy and Mobility” (e.g. destinations 5 and 6).

Proposals under this topic should exploit synergies and be complementary to national activities and activities funded by ESA.

Applicants are welcome to use the European space data infrastructures, e g. Galileo Service Centre, EGNOS Data Access Service (EDAS) and the EGNOS user support facilities (ASQF).

Call - STRATEGIC AUTONOMY IN DEVELOPING, DEPLOYING AND USING GLOBAL SPACE-BASED INFRASTRUCTURES, SERVICES, APPLICATIONS AND DATA 2022 - APPLICATIONS

HORIZON-EUSPA-2022-SPACE-02

Conditions for the Call

Indicative budget(s)[311]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[312]	Number of projects expected to be funded
		2022		
Opening: May 2022 (indicative) Deadline(s): Sep 2022 (indicative)				
HORIZON-EUSPA-2022-SPACE-02-51	IA	9.50 [313]	2.00 to 3.00	3
HORIZON-EUSPA-2022-SPACE-02-52	PCP	5.20	2.60 to 5.20	2
HORIZON-EUSPA-2022-	IA	9.60 [314]	2.00 to 3.00	3

311 The Agency 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 Agency 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.

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

313 Of which EUR 8.22 million from the 'NGEU' Fund Source.

314 Of which EUR 8.30 million from the 'NGEU' Fund Source.

SPACE-02-54				
HORIZON-EUSPA-2022-SPACE-02-55	RIA	9.60 [315]	2.00 to 3.00	3
HORIZON-EUSPA-2022-SPACE-02-56	RIA	5.10	0.50 to 1.00	5
HORIZON-EUSPA-2022-SPACE-02-61	RIA	9.10 [316]	1.00 to 1.50	6
Overall indicative budget		48.10		

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

This call and resulting actions will be implemented under indirect management by the European Union Space programme Agency - EUSPA (the former European GNSS Agency - GSA), subject to the conclusion of a contribution agreement with the Commission.

Development of applications from the EU space programme components

Proposals are invited against the following topic(s):

HORIZON-EUSPA-2022-SPACE-02-51: EGNSS applications for Smart mobility

[315] Of which EUR 8.30 million from the 'NGEU' Fund Source.
[316] Of which EUR 7.87 million from the 'NGEU' Fund Source.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.50 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL7-9 by the end of the project – see General Annex B.

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

- Development of EGNSS based accuracy, 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, supporting new policies aimed to incentivise green and sustainable transportation of goods and people.
- The action aims at fostering the EGNSS market uptake in transport. Applications should demonstrate the advantage of Galileo and EGNOS specific features and differentiators for their use in smart and green mobility, and should 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 and future drone-port 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, polar routes surveillance against

space weather events and drive the modernization of the sector (e.g. Internet of boats, automation, autonomous sea cleaning, 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 signalling and its inclusion into the evolution of the European Train Control System (ETCS), efficiency-focused innovations enabling cost reductions, 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 should ensure that the EU railways sector keeps pace with rest of the world, where the adoption of space-based services already started. Maintenance of rail existing infrastructure and support to new lines is also considered.

- **Road**: EGNSS solutions for regulated markets that reduce traffic, optimise fuel consumption, lower emissions, and foster cheaper, smarter, safer and greener transportation, including smart public transportation. EGNSS solutions to support the development of connected and autonomous driving, next generation vehicles and novel user equipment, new capacities for vehicles, e.g. intelligent speed adaptation, and the use of integrated space data for road safety and environment, such as monitorisation of road infrastructures (e.g. landslides and bridge infrastructure), and AI-based cyber threat mitigation (e.g. spoofing attacks on localization). EGNSS solutions that benefit from 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, indicating the necessary scale-up needs to wide adoption in Europe and worldwide and associated standards and certification.

Developed applications should have a clearly defined commercial potential and should respond to user needs. The solution developed is expected to achieve TRL7-9 by the end of the project.

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, or outreach to, 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 is compulsory and should be provided as part of the proposal, to demonstrate the user need and sustainability of the project, and opportunities for wide adoption in Europe according to standards and operational needs.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

Applicants are advised to exploit all possible synergies with other transport and mobility specific actions funded under the work programme of Cluster 5 "Climate, Energy and Mobility"

Proposals under this topic should exploit synergies and be complementary to national activities and activities funded by ESA.

Applicants are welcome to use the European space data infrastructures, e g. Galileo Service Centre, EGNOS Data Access Service (EDAS) and the EGNOS user support facilities (ASQF).

HORIZON-EUSPA-2022-SPACE-02-52: Public sector as Galileo and/or Copernicus user

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.60 and 5.20 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.20 million.
Type of Action	Pre-commercial Procurement

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 modernisation of the public sector.

- Enable public procurers to collectively implement PCPs 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,validation and certification (when applicable) 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 and midcaps 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, GOVSATCOM), as well as to proposals requiring end-to-end solutions that need combinations of different space components.

The topic is dedicated to 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. Projects should focus on very specific and more mature applications and market segments, based on clearly identified needs. 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, including support to new green policies,

- 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, earthquakes, volcanic eruptions, space weather)

- Copernicus and/or EGNSS for civil security applications and border management
- 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 should 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.

The requested solutions should be validated through field-testing by the participating procurers in at least two different countries across Europe.

Applicants should take particular attention to ensure giving sufficient time for the different PCP phases.

Applicants are recommended to use European data infrastructures such as, for example, the DIAS platforms and the Galileo Service Centre and EGNOS user support facilities.

Proposals addressing PRS (Public Regulated Service) related applications are not in the scope of this action.

HORIZON-EUSPA-2022-SPACE-02-54: Copernicus downstream applications and the European Data Economy

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.60 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL8 by the end of the project – see General Annex B.

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 should be user-friendly and work at the scale of the large quantities of data involved. They should be adopted to contribute to the digitization challenges of the European industry by opening up innovative business avenuesopportunities and to support societal challenges.

Copernicus data and services products will be at the core of the projects' data value chains and integration activatesactivities 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.

Applicants 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.

Activities are expected to start at TRL 5 and achieve TRL 8 by the end of the project.

HORIZON-EUSPA-2022-SPACE-02-55: Large-scale Copernicus data uptake with AI and HPC

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 2.00 and 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.60 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5 by the end of the project – see General Annex B.

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, applicants are requested to respond to one of the following challenges:

- 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, AI, High Performance Computing (HPC,), Big Data processing and management, and the integration with distributed data sources from other industrial domains.

- 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 applicants 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.

Activities are expected to start at TRL 3 and achieve TRL 5 by the end of the project.

HORIZON-EUSPA-2022-SPACE-02-56: Designing space-based downstream applications with international partners

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.10 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: Due to the scope of this topic, legal entities established in countries that have signed an administrative cooperation arrangements on Copernicus data access and Earth observation data exchange are exceptionally eligible for Union funding. Currently, these countries are: 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).
Technology Readiness Level	Activities are expected to achieve TRL3-4 by the end of the project – see General Annex B.

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) nd EU know-how.

2. The use of Copernicus data, to develop jointly 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 positing 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.

- Maximise 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.

- Create partnerships 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.

- Build capacity 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-spaced based assets and services, with a preference given to those based in the EU and in the international cooperation partners 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 of 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 value-added 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. European Union Aviation Safety Agency (EASA), European Satellite Service Providers (ESSP) or Member States' Air Navigation Service Providers for EGNOS Safety of Life service to aviation, European Maritime Safety Agency (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.

HORIZON-EUSPA-2022-SPACE-02-61: GOVSATCOM Service developments and demonstrations

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 1.00 and 1.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9.10 million.
Type of Action	Research and Innovation Actions
Eligibility	The conditions are described in General Annex B. The following

conditions	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. In accordance with paragraph 11 of Annex IV of the Regulation (EU) 2021/695 establishing Horizon Europe, this action is implemented with regard to eligibility of legal entities in accordance with the Union Space Programme. In particular, for the reasons of EU strategic autonomy in space and the security and integrity of EU space assets, in order to guarantee the protection of the strategic interests of the Union and its Member States, legal entities established in any Member State will be eligible to participate where these entities comply with the conditions established in Article 24 of the Regulation (EU) 2021/696[317].

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 and interoperability of services. 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.

Scope:

- R&I for the consolidation of integrated use cases and demonstration of EU GOVSATCOM service interoperability in real user environment.
    1. Development of an innovative use case (e.g. in the area of crisis management, surveillance, critical infrastructure etc.) exploiting a combination of secure SATCOM services, such as Mobile Satellite Service (MSS) and Fixed Satellite Service (FSS);
    2. Interoperability of services based on pooled and shared capacities from different satellite systems;

[317] https://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=uriserv:OJ.L_.2021.170.01.0069.01.ENG&toc=OJ:L:2021:170:TOC

3. Interoperability of governmental satellite-based communication services with terrestrial communication services;
4. Development of end to end secure, interoperable, quickly deployable, affordable and user-friendly GOVSATCOM user services ;
5. Integrated application leveraging the synergies with services provided by other Space Programme components (Galileo, EGNOS, Copernicus, SSA);
6. Proof of concept in a real user environment;
7. Awareness and outreach activities in favour of EU GOVSATCOM user uptake.

- R&I Areas to be addressed:

1. Interoperability between satellite communication systems' services;
2. Seamless handover between satellite and terrestrial communications networks for the provision of governmental communications services;
3. Service level interoperability between commercial and MS owned satellite communications systems;
4. Integration of EU GOVSATCOM services with services provided by the other components of the Space Regulation.

Budget[318]

	Budget line(s)	2021 Budget (EUR million)	2022 Budget (EUR million)
Calls			
HORIZON-CL4-2021-TWIN-TRANSITION-01		403.00	
	from 01.020240	*286.40*	
	from 01.020240 - NGEU	*116.60*	
HORIZON-CL4-2022-TWIN-TRANSITION-01			334.50
	from 01.020240		*188.35*
	from 01.020240 - NGEU		*146.15*
HORIZON-CL4-2021-RESILIENCE-01		355.20	
	from 01.020240	*199.57*	
	from 01.020240 - NGEU	*155.63*	
HORIZON-CL4-2021-RESILIENCE-02		10.00	
	from 01.020240	*4.45*	
	from 01.020240 - NGEU	*5.55*	
HORIZON-CL4-2022-RESILIENCE-01			402.20

318 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.

	from 01.020240		*265.55*
	from 01.020240 - NGEU		*136.65*
HORIZON-CL4-2022-RESILIENCE-02-PCP			9.00
	from 01.020240		*3.62*
	from 01.020240 - NGEU		*5.38*
HORIZON-CL4-2021-DATA-01		141.00	
	from 01.020240	*110.09*	
	from 01.020240 - NGEU	*30.91*	
HORIZON-CL4-2022-DATA-01			205.00
	from 01.020240		*162.62*
	from 01.020240 - NGEU		*42.38*
HORIZON-CL4-2021-DIGITAL-EMERGING-01		311.90	
	from 01.020240	*280.32*	
	from 01.020240 - NGEU	*31.58*	
HORIZON-CL4-2021-DIGITAL-EMERGING-02		23.00	28.00
	from 01.020240	*23.00*	*28.00*
HORIZON-CL4-2022-DIGITAL-			116.50

EMERGING-01	*from 01.020240*		*116.50*
HORIZON-CL4-2022-DIGITAL-EMERGING-02			127.00
	from 01.020240		*127.00*
HORIZON-CL4-2021-SPACE-01		136.22	
	from 01.020240	*65.13*	
	from 01.020240 - NGEU	*71.09*	
HORIZON-CL4-2022-SPACE-01			85.70
	from 01.020240		*57.68*
	from 01.020240 - NGEU		*28.03*
HORIZON-CL4-2021-HUMAN-01		206.00	
	from 01.020240	*206.00*	
HORIZON-CL4-2022-HUMAN-01			70.50
	from 01.020240		*70.50*
HORIZON-CL4-2022-HUMAN-02			50.50
	from 01.020240		*50.50*
Contribution from this part to call HORIZON-MISS-2021-COOR-01 under Part 12 of the work programme		0.58	
	from 01.020240	*0.58*	
Contribution from this part to call HORIZON-MISS-2021-NEB-01 under Part 12 of the work programme		7.28	
	from 01.020240	*7.28*	

Contribution from this part to call HORIZON-MISS-2021-CIT-02 under Part 12 of the work programme		11.75	
	from 01.020240	*11.75*	
Contribution from this part to call HORIZON-MISS-2021-OCEAN-05 under Part 12 of the work programme		0.94	
	from 01.020240	*0.94*	
Contribution from this part to call HORIZON-MISS-2021-OCEAN-02 under Part 12 of the work programme		5.98	
	from 01.020240	*5.98*	
Contribution from this part to call HORIZON-MISS-2021-OCEAN-04 under Part 12 of the work programme		1.99	
	from 01.020240	*1.99*	
Contribution from this part to call HORIZON-MISS-2021-OCEAN-03 under Part 12 of the work programme		1.99	
	from 01.020240	*1.99*	
Contribution from this part to call HORIZON-MISS-2021-CLIMA-01 under Part 12 of the work programme		1.00	
	from 01.020240	*1.00*	
Contribution from this part to call HORIZON-MISS-2021-CLIMA-02 under Part 12 of the work programme		10.78	
	from 01.020240	*10.78*	
Contribution from this part to call HORIZON-MISS-2021-CANCER-02 under Part 12 of the work programme		31.81	
	from 01.020240	*31.81*	
Contribution from this part to call HORIZON-MISS-2022-CIT-01 under Part 12 of the work programme			5.46
	from 01.020240		*5.46*
Contribution from this part to call HORIZON-MISS-2021-SOIL-02 under Part 12 of the work programme		11.10	
	from 01.020240	*11.10*	
Other actions			

Grant awarded without a call for proposals according to Financial Regulation Article 195			52.00
	from 01.020240		*52.00*
Grant to identified beneficiary according to Financial Regulation Article 195(e)		1.10	0.10
	from 01.020240	*1.10*	*0.10*
Specific grant agreement			143.60
	from 01.020240		*109.00*
	from 01.020240 - NGEU		*34.60*
Public procurement		16.10	20.20
	from 01.020240	*16.10*	*20.20*
Expert contract action		4.05	7.75
	from 01.020240	*4.05*	*7.75*
Provision of technical/scientific services by the Joint Research Centre		4.10	0.60
	from 01.020240	*4.10*	*0.60*
Indirectly managed action		112.80	112.90
	from 01.020240	*93.08*	*80.21*
	from 01.020240 - NGEU	*19.72*	*32.69*
Contribution from this part to Indirectly managed action under Part 12 of the work programme		0.58	
	from 01.020240	*0.58*	
Contribution from this part to Grant		0.56	

awarded without a call for proposals according to Financial Regulation Article 195 under Part 12 of the work programme	*from 01.020240*	*0.56*	
Contribution from this part to Grant to identified beneficiary according to Financial Regulation Article 195(e) under Part 12 of the work programme		0.04	
	from 01.020240	*0.04*	
Contribution from this part to Provision of technical/scientific services by the Joint Research Centre under Part 12 of the work programme		0.56	
	from 01.020240	*0.56*	
Contribution from this part to Service Level Agreement under Part 12 of the work programme		0.20	
	from 01.020240	*0.20*	
Contribution from this part to Public procurement under Part 12 of the work programme		2.69	
	from 01.020240	*2.69*	
Contribution from this part to Expert contract action under Part 12 of the work programme		0.44	0.44
	from 01.020240	*0.44*	*0.44*
Contribution from this part to Specific grant agreement under Part 12 of the work programme			10.53
	from 01.020240		*10.53*
Estimated total budget		1814.75	1782.47