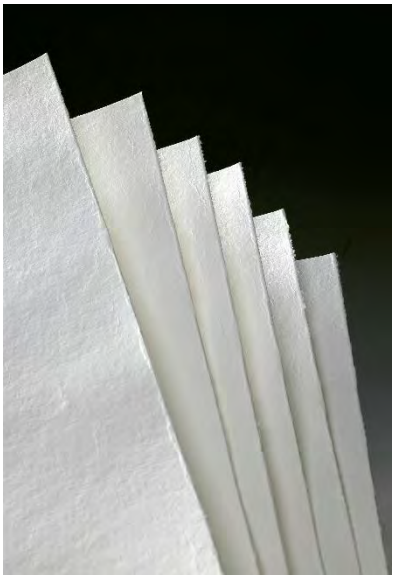
FTP CALL TOPICS MANUAL HORIZON EUROPE 2021-2022

The complete manual for the Call topics relevant for the pulp & paper sector



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Forest-based Sector
Technology Platform

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Introduction

Horizon Europe is the EU's key funding programme for research and innovation for 2021-2027. After more than three years of negotiations, it has finally been approved by the European Parliament on the 27th April 2021. The approved budget amount is € 95,5 billion in current prices.

Horizon Europe is structured into three main Pillars. Pillar I focus on the funding of excellent science through the European Research Council and young researchers through the Marie Sklodowska-Curie grants programme. It also funds European research infrastructures.

Pillar II addresses global challenges and increasing the competitiveness of the European industry. Pillar II is divided into 6 thematic sub-budgets that are called Clusters. The third Pillar focus on innovation and acts mainly through the European Innovation Council and the European Institute of Technology.

For the stakeholders of the European Technology Platform for the forest-based sector (FTP), the most relevant funding opportunities are found under Pillar II Clusters 4, 5 and 6.

Cluster 4 is called 'Digital, Industry and Space', Cluster 5 is called 'Climate, Energy and Mobility', and Cluster 6 has the rather long title 'Food, Bioeconomy, Natural Resources, Agriculture and Environment'. Each Cluster has a sub-budget, called Work Programme, that identifies Call Topics for a period of two or three years. **Call Topic Manual covers the relevant Call Topics of the 2021-2022 Work Programmes for Clusters 4, 5 and 6**.

The Horizon Europe budget is distributed by competitive Calls for Proposals. This means that applicants have to submit proposals that will be evaluated and scored by external experts and only the best scoring proposals will be funded under each Call for Proposals.

The proposals, if they are funded, are annexed as part of the contract between the applicants and the European Commission. A proposal could be compared to a business plan of a start-up company. If the proposals are funded or not will depend on how they are ranked in the evaluation by independent experts. The scoring is based on three main criteria; **Excellence** (is the idea sound, is the proposal actually covering the scope of the Call, etc), **Impact** (how will the outcomes of the project contribute to the objectives of the Call and relevant EU objectives), and **Quality and efficiency of the implementation** (is the project well planned in terms of budget, are all the reports and deliverables relevant and well described, Are the project milestones relevant and are there contingency plans prepared if the project run into problems). Although all three criteria are scored equally, the Impact criteria is usually considered the most important of the three.

This FTP Manual showcases a list of the most relevant Call topics for the forest-based sector. Each Call contains topics and each topic describes the specific challenge to be addressed, the scope of the activities to be carried out, and the expected impacts to be achieved by the projects proposed. The relevant topics selected and compiled in this manual are arranged with the link to the corresponding Research and Innovation Areas *of FTP's Strategic Research and Innovation Agenda for 2030 (SIRA 2030)*.

Proposals can be submitted electronically through the European Commission's Funding and Tenders Portal. The complete list and description of Calls and further guidance to submit a proposal are also published on the Portal.

Preparing a proposal takes time and effort. By this version of the FTP Call Topics Manual, we wish to give our stakeholders the advantage of an early start.

The three Work Programme documents we have analysed for this document, together constitute close to 2000 pages text and several hundreds of Call Topics. We have identified approximately 150 of those Call Topics as relevant for stakeholders in the forest-based sector.

Information on the Call Topics in this Manual will also be available on the FTP Database.

Horizon Europe (2021-2027) with its dedicated budget of around €95 billion is the biggest EU Research and Innovation programme ever.

Budget for 2021–2022: Call topics relevant for the pulp & paper sector

	Number of Calls	Funding (million EUR)
Cluster 4 – Digital, Industry and Space	**39 (12 Indirect)**	**788,8**
Destination 1 - Climate neutral, circular and digitised production	13 (1 indirect)	314,5
Destination 2 - Increased autonomy in key strategic value chains for resilient industry	17 (4 indirect)	342
Destination 4 - Digital and emerging technologies for competitiveness and fit for the Green Deal	9 (4 indirect)	169,5
Destination 6 - A human-centred and ethical development of digital and industrial technologies	4 (3 indirect)	19,5
EUSPA	3	32,9
Cluster 5 – Climate, Energy and Mobility	**11 (1 Indirect)**	**159**
Destination 2 - Cross-sectoral solutions for the climate transition	1	20
Destination 3 - Sustainable, secure and competitive energy supply	8 (1 indirect)	113
Destination 4 - Efficient, sustainable and inclusive energy use	2	26
Cluster 6 – Food, Bioeconomy, Natural Resources, Agriculture and Environment	**20 (1 Indirect)**	**167**
Destination 1 - Biodiversity and ecosystem services	4	32
Destination 3 - Circular economy and bioeconomy sectors	11 (1 indirect)	108
Destination 4 - Clean environment and zero pollution	3	19
Destination 7 - Innovative governance, environmental observations and digital solutions in support of the Green Deal	2	8
MISSIONS	**1 (1 indirect)**	**5**
Mission: Adaptation to climate change	1 (1 indirect)	5
Total all Calls	**71 Calls (15 indirect)**	**1119,8 mln EUR**
Total (High, Medium, Low)	**56 Calls**	**940,8 mln EUR**

How to read this manual: The Call Topic Headers

For each Call Topic, we provide in the header key information such as the Call publication date, application deadline(s), Call budget, recommended EU funding per project, starting TRL and ending TRL (TRL=Technology Readiness Levels).

Further on, to assist the reader to find their way to the Call Topics of highest relevance to them, we have introduced a few concepts in the header of each Call Topic: FTP Subsector, Relevance, Keywords, FTP Comment and FTP SIRA 2030.

FTP Subsector: F&F, WW, P&P + Biodiversity, Bioenergy, Policy

This manual makes a very broad classification of the forest-based sector into three subsectors: forests and forestry, pulp & paper industries, and woodworking industries.

In many cases, the scope of the Call Topic is relevant to actors in more than one subsector and if the scope covers, chain-of custody, life-cycle analysis, circular economy etc, we have included the whole value-chain, I.e., all three subsectors in this identification.

Forests and Forestry (abbreviated F&F): Sustainable forest management, forest-related sciences, remote sensing technologies, plant breeding and much more.

WoodWorking Industries (abbreviated WW) includes sawmilling, building with wood, wood manufacturing, boards, panel industry, carpentry, wood composite products like CLT, construction, reuse and recycling and much more.

Pulp & Paper Industries (abbreviated P&P): packaging, paper, biocomposites, biochemicals, hygiene and healthcare products, nanocellulose, foams, gels, recycling and reuse and much more.

Besides these three subsectors, we sometime use Biodiversity, Bioenergy and Policy to emphasise the scope of the Call Topic.

Relevance: High, Medium, Low, Indirect

High relevance is used when the Call Topic is specifically targeting an area of the forest-based sector, or when it is targeting a broader context but addresses a challenge of very high relevance to the sector.

Medium relevance is used when the Call Topic is relevant but the scope is encompassing for instance agriculture AND forestry, or process industries in general.

Low relevance is used when the topic is either covering a very narrow, special niche of the forest-based sector (e.g. New biocompatible healthcare products), or when the scope is

broadly relevant to a much larger group of actors (e.g. a topic on transport and logistics solutions).

Indirect relevance is used when the actors in the forest-based sector should keep an eye of future outcomes, but the Call Topic is unlikely to be addressed by FTP stakeholders. For instance, projects related to standardisation of earth observation data from satellites or studies of climate change effects on biodiversity. Those indirect topics can be found in Annex 1.

Keywords are selected from the Call Topic description.

FTP Comment: I some cases, we have made some own reflections and recommendations on the call topics that we have collected.

FTP SIRA 2030: Here we identify which of the ten Vision Targets and the related Challenges that are described in the FTP Strategic Research and Innovation Agenda 2030 that could be considered addressed by the call topic.

10 Visions Targets and Challenges of SIRA 2030:

1	Sustainable forest management, biodiversity and resilience to climate change
1.A	Capitalizing on the interdependencies between forest management anf functional diversity
1.B	Strenghtening forest ecosystem resilience and fostering Climate Smart Forestry
1.C	Enhancing the vital role of forests in regional and continental water supply
1.D	Mitigating wildfire risks in forested landscapes
1.E	Improving the partnership with citizens
2	Increased, sustainable wood production and mobilization
2.A	Improving seeds, seedlings and plants to increase productivity and resilience
2.B	Using digital revolution for precision forestry
2.C	Empowering small-scale forest owners
2.D	Harnessing novel technologies and automation in forest operations
2.E	Analysing and foresighting markets and material flows of forest-based products
3	More added value from non-wood ecosystem services
3.A	Improving business opportunities for non-wood forest products
3.B	Enhancing value creation with other ecosystem services
3.C	Providing forest-based benefits for urban and peri-urban societies
3.D	Identifying the benefits of forest expansion as a consequence of land-use change
3.E	Innovation in forest governance to promote forest-based benefits for society
4	Towards a zero-waste, circular society
4.A	Optimizing material recovery through efficient collection, sorting and separation
4.B	Adapting reuse and recycling technologies to complex products
4.C	Defining methods for cost assessment and optimization of recycling
4.D	Boosting the circularity of forest fibres and wood products
5	Efficient use of natural resources
5.A	Reducing energy consumption in biorefineries, including pulp and paper mills

5.B	Optimizing the use of raw materials by exact control of natural variations
5.C	Improving raw material efficiency and production value in wood-based manufacturing
5.D	Improving water balance and process water treatment
6	Diversification of production technologies and logistics
6.A	Developing industrial symbiosis
6.B	Creating new biorefinery concepts for the circular and biobased economy
6.C	Adopting additive manufacturing technologies and new production methods
6.D	Extracting and producing natural compounds with high added value
6.E	Improving traceability and chain-of-custody throughout the value chain
6.F	Integrating autonomous and/or electrified harvesting and transportation systems
7	Purposeful, safe jobs and links between rural and urban regions
7.A	Growing the forest-based sector through creative jobs
7.B	Creating job opportunities along the value chain through proactive management of small forest ownerships
7.C	Developing new marketplaces and jobs in response to changing consumer trends
7.D	Adapting job offers in an era of Artificial Intelligence (AI)
7.E	Improving operator safety and ergonomics
8	Renewable building materials for healthier living
8.A	Developing new building systems, including modular and pre-fabricated systems
8.B	Improving wood-based products, including engineered wood and composites
8.C	Harmonization and standardization research and more intelligent, digital design tools
8.D	Exploring the experience of living with wood and its health benefits
9	New fibre-based products and 80 per cent lower CO2 emissions
9.A	Providing sustainable, fibre-based, high-value consumer products
9.B	Developing more sustainable and competitive processes for paper-making and other biobased products
9.C	Developing building blocks for biobased materials and chemicals in the circular society
9.D	Adding value through digitalization and functionalization
10	Renewable energy for society
10.A	Developing new, efficient production systems for advanced, clean biofuels and chemicals
10.B	Enhancing the valorization of forest residues
10.C	Establishing integrated and holistic energy systems (including energy storage and managing demand fluctuations)
10.D	Supporting fact-based decision-making on bioenergy-related issues

DISCLAIMER: Please be aware that only the officially published Work Programme (WP) text, budget and deadlines should be taken as a reference for any proposal preparation. All applicants should consult the Funding and Tenders Portal to find the latest version.

Pillar II : Global challenges and European industrial competitiveness Pillar

Cluster 4: Digital, Industry and Space[1]

Destination 1: Climate neutral, circular and digitised production

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

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

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

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

Accelerating the twin green and digital transitions will be key to building a lasting and prosperous growth, in line with the EU's new growth strategy, the European Green Deal. Europe's ability to lead the twin transitions will require new technologies, with investment and innovation to match. Research and innovation will be fundamental to create the new

[1] Work Programme published by the European Commission on 15 June 2021

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 added2. 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:

- Accelerate the twin green and digital transition of the manufacturing and construction sectors;
- Create a new green, flexible and digital way to build and produce goods. This will lead to sustainable, flexible, responsive and resilient factories and value chains, enabled by digitisation, AI, data sharing, advanced robotics and modularity. At the same time it will help reduce CO2 emissions and waste in these sectors, and enhance the durability, reparability and re-cycling of products/components. It will also ensure better and more efficient use of construction-generated data to sustain competitiveness and greening of the sector;
- Make the jobs of the humans working in the manufacturing and construction sectors more attractive and safer, and point the way to opportunities for upskilling;
- Set out a credible pathway to contributing to climate neutral, circular and digitalised energy intensive industries;
- Increase productivity, innovation capacity, resilience, sustainability and global competitiveness of European energy intensive industries. This includes 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 CO2/CO streams; and electrifying industry to enable and foster a switch to a renewable energy system;
- Contribute to a substantial reduction of waste and CO2 emissions, turning them into alternative feedstocks to replace fossil-based raw materials and decrease reliance on imports.

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' principle4. 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 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 CO2/CO
- Integration of Renewables and Electrification in process industry

Call – Twin green and digitised transition 2021

Green, flexible and advanced manufacturing

Topic ID and title	HORIZON-CL4-2021-TWIN-TRANSITION-01-05: Manufacturing technologies for bio-based materials (Made in Europe Partnership) (RIA)				
Budget	EUR 20 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 4 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Value chain, recycling, bioplastics, biopolymers, fibre-based materials, cellulose-based components, product lifecycle, construction, packaging, textiles				
FTP comments					
FTP SIRA 2030 Challenges addressed	8A,B - 9 - 6			**FTP relevance**	Medium
				Starting TRL	4
				End TRL	6

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

Topic ID and title	HORIZON-CL4-2021-TWIN-TRANSITION-01-08: Data-driven Distributed Industrial Environments (Made in Europe Partnership) (IA)				
Budget	EUR 24 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 4 to 8 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	WW, P&P				
Keywords	Efficient data processing, private 5G networks (5G NPN), cybersecurity, deep industrial data				
FTP comments					
FTP SIRA 2030 Challenges addressed	6A,E,F			**FTP relevance**	Low
				Starting TRL	4
				End TRL	7

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 data15, 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.

- 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

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

Topic ID and title	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)				
Budget	EUR 28 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 8 to 12 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	Cross-sectorial symbiosis, sensing technologies, IoT, digital tools, Artificial Intelligence (AI), flow optimization, life cycle assessment (LCA)				
FTP comments					
FTP SIRA 2030 Challenges addressed	4 – 8A,B – 10C			**FTP relevance**	Low
				Starting TRL	4
				End TRL	6

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 action21 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;

- 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 projects22 is strongly encouraged, see also Industrial Symbiosis Report from March 202023.

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.

Topic ID and title	HORIZON-CL4-2021-TWIN-TRANSITION-01-16: Hubs for Circularity European Community of Practice (ECoP) platform (Processes4Planet Partnership) (CSA)				
Budget	EUR 2 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 2 million			**Deadline 2**	/
Type of action	Coordination and Support Actions (CSA)				
FTP subsector	P&P				
Keywords	industrial urabn-symbiosis (I-US), circular value chains, hubs for circulartity (H4C), public and private investments				
FTP comments	SPIRE Hubs4Cicularity concept				
FTP SIRA 2030 Challenges addressed	4			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

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.
- 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.

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 projects25 is strongly encouraged, see also Industrial Symbiosis Report from March 2020.26.

This topic implements the co-programmed European partnership Processes4Planet.

Integration of Renewable and Electrification in process industry

Topic ID and title	HORIZON-CL4-2021-TWIN-TRANSITION-01-21: Design and optimisation of energy flexible industrial processes (Processes4Planet Partnership) (IA)				
Budget	EUR 39 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 12 to 18 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Process flexibility, onsite energy storage, energy grid platforms, cost reduction, digital tools, Artificial Intelligence (AI)				
FTP comments					
FTP SIRA 2030 Challenges addressed	5A – 10C			**FTP relevance**	Medium
				Starting TRL	5
				End TRL	7

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.

Call – Climate Neutral, circular and digitised production 2022

Green, flexible and advanced manufacturing

Topic ID and title	HORIZON-CL4-2022-TWIN-TRANSITION-01-01: Rapid reconfigurable production process chains (Made in Europe Partnership) (IA)				
Budget	EUR 27,5 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 8 to 10 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Reconfiguration time reduction, Standardised protocols, flexible manufacturing processes, Artificial Intelligence (AI)				
FTP comments					
FTP SIRA 2030 Challenges addressed	5A,C - 6			**FTP relevance**	Low
				Starting TRL	5
				End TRL	7

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.

Topic ID and title	HORIZON-CL4-2022-TWIN-TRANSITION-01-02: Products with complex functional surfaces (Made in Europe Partnership) (RIA)				
Budget	EUR 21,5 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 4 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Surface treatments, thermo-chemical processes, thermal treatments, additive manufacturing, biochemical treatments				
FTP comments					
FTP SIRA 2030 Challenges addressed	6C – 9C – 10A			**FTP relevance**	Low
				Starting TRL	4
				End TRL	6

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.

Advanced digital technologies for manufacturing

Topic ID and title	HORIZON-CL4-2022-TWIN-TRANSITION-01-06: ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2) (Made in Europe Partnership) (IA)				
Budget	EUR 30 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 4 to 8 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	digital technologies, safer job, waste reduction, lower energy, lower carbon footprint, agility, Artificial Intelligence (AI), Internet of Things (IoT)				
FTP comments					
FTP SIRA 2030 Challenges addressed	5 - 7			**FTP relevance**	Low
				Starting TRL	5
				End TRL	7

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.

Topic ID and title	HORIZON-CL4-2022-TWIN-TRANSITION-01-07: Digital tools to support the engineering of a Circular Economy (Made in Europe Partnership) (RIA)				
Budget	EUR 22 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 3 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	innovative digital tools, engineers, technicians, operators, recycling, reuse, material consumption reduction, secondary raw materials, data exchange, transparency and traceability increasing, circular economy				
FTP comments					
FTP SIRA 2030 Challenges addressed	4 – 5C – 6E – 8C			**FTP relevance**	Low
				Starting TRL	3-4
				End TRL	6

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.

Integration of Renewables and Electrification in process industry

Topic ID and title	HORIZON-CL4-2022-TWIN-TRANSITION-01-17: Integration of hydrogen for replacing fossil fuels in industrial applications (Processes4Planet Partnership) (IA)				
Budget	EUR 42,5 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 12 to 18 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	CO2 emissions reduction, energy efficiency, heating process				
FTP comments					
FTP SIRA 2030 Challenges addressed	10A,B			**FTP relevance**	Low
				Starting TRL	5
				End TRL	7

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 2: Increased autonomy in key strategic value chains for resilient industry

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

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

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

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

The COVID-19 crisis has shown that global competitiveness and resilience are two sides of the same coin42. 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.

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 increase43, 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 Europe44. To overcome its reliance on imports of basic chemicals and related materials, Europe needs to strengthen its capacity to produce and use chemicals in a sustainable and competitive way. In addition, it is necessary to continue work on an ecosystem, based on open innovation test beds (OITBs), which enables the rapid development, uptake and commercialisation of advanced materials. All actions should be guided by sustainable-by-design principles, i.e. environmental and health safety, circularity and functionality.

- *Circular value chains*: to complement the circular technologies in Destination 1, further technological and non-technological elements (such as business models and the

traceability of products) are necessary in the transition to novel low-emission and circular industrial value chains.

- *Preparedness of businesses/smes/startups*: European companies, and in particular SMEs, have shown a chronic lagging behind the US and China in the uptake of new, and 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' principle46. 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.
- 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.

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Novel paradigms to establish resilient and circular value chains

Topic ID and title	HORIZON-CL4-2021-RESILIENCE-01-01: Ensuring circularity of composite materials (Processes4Planet Partnership) (RIA)				
Budget	EUR 24,7 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 8 to 9 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Secondary raw materials, new value streams, dismantling, sorting, reuse, recycle				
FTP comments					
FTP SIRA 2030 Challenges addressed	4			**FTP relevance**	Medium
				Starting TRL	3
				End TRL	6

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

Topic ID and title	HORIZON-CL4-2021-RESILIENCE-01-04: Developing climate-neutral and circular raw materials (IA)				
Budget	EUR 36 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 12 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	WW, P&P				
Keywords	Sorting technologies, recycling, wood-based materials, construction, forest-based raw materials, wood-based panels, multi-material paper packaging				
FTP comments					
FTP SIRA 2030 Challenges addressed	4			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	6-7

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.

Green and Sustainable Materials

Topic ID and title	HORIZON-CL4-2021-RESILIENCE-01-11: Safe- and sustainable-by-design polymeric materials (RIA)				
Budget	EUR 19 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 4 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	Polymers, additives, recycling				
FTP comments					
FTP SIRA 2030 Challenges addressed	4 – 6E – 9C			**FTP relevance**	Low
				Starting TRL	3
				End TRL	5

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.

Materials for the benefit of society and the environment and materials for climate-neutral industry

Topic ID and title	HORIZON-CL4-2021-RESILIENCE-01-20: Antimicrobial, Antiviral, and Antifungal Nanocoatings (RIA)				
Budget	EUR 23 million	**Opening date**	22 June 2021	**Deadline 1**	23 September 2021
Budget per project	EUR 4 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	Pathogens, public health, bio-based materials				
FTP comments					
FTP SIRA 2030 Challenges addressed	6D – 9C			**FTP relevance**	Low
				Starting TRL	3
				End TRL	6

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;

- 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.

Call – A digitised, resource-efficient and resilient industry 2022

Novel paradigms to establish resilient and circular value chains

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-01: Circular and low emission value chains through digitalisation (Processses4Planet Partnership) (RIA)				
Budget	EUR 25,3 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 6 to 8 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Waste reduction, digital technologies, secondary raw materials, certification				
FTP comments					
FTP SIRA 2030 Challenges addressed	4B – 8C			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

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.

Green and Sustainable Materials

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-11: Advanced lightweight materials for energy efficient structures (RIA)				
Budget	EUR 20 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Reduction of production cost, bio-based materials, bioresins, recycled fibres, bio-fibres,				
FTP comments					
FTP SIRA 2030 Challenges addressed	8A,B – 9A,C			**FTP relevance**	Medium
				Starting TRL	3
				End TRL	5

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 CO2 emissions (LCA) of at least 20 %;
- Business models and circular value chains for lightweight bio based components;
- Improved time-to-market for European providers of lightweight solutions.

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

Scope:

A step change is needed to develop new sustainable and high performance lightweight materials and associated novel manufacturing techniques 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.

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)				
Budget	EUR 20 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 4 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Additive manufacturing, biomaterials, energy efficiency, nanotechnology, recycling				
FTP comments					
FTP SIRA 2030 Challenges addressed	8A,B – 9A,C,D			**FTP relevance**	Low
				Starting TRL	3
				End TRL	6

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 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.

Materials for the benefit of society and the environment and materials for climate-neutral industry

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-13: Smart and multifunctional biomaterials for health innovations (RIA)				
Budget	EUR 20 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	Biocompatibility, biospecificity, longevity of medical devices, bioactivity, biodegrability,				
FTP comments					
FTP SIRA 2030 Challenges addressed	9A,C			**FTP relevance**	Low
				Starting TRL	3
				End TRL	5

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 shall 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.

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-14: Membranes for gas separations - membrane distillation (IA)				
Budget	EUR 21 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 6 to 8 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Recycling, waste streams, separation performance, wastewater, waste gas, desalination, end-of-life				
FTP comments					
FTP SIRA 2030 Challenges addressed	4 - 5C			**FTP relevance**	Low
				Starting TRL	4
				End TRL	7

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.

Materials and data cross-cutting actions

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-19: Advanced materials modelling and characterisation (RIA)				
Budget	EUR 18 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 4 to 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	Open repository, material properties, CHADA, MODA, EMMO, model-based innovation processes, product development, material development, Artificial Intelligence (AI), Machine Learning				
FTP comments					
FTP SIRA 2030 Challenges addressed	9C,D - 10A,B			**FTP relevance**	High
				Starting TRL	3
				End TRL	5

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.

Topic ID and title	HORIZON-CL4-2022-RESILIENCE-01-20: Climate Neutral and Circular Innovative Materials Technologies Open Innovation Test Beds (IA)				
Budget	EUR 34 million	**Opening date**	12 October 2021	**Deadline 1**	30 March 2022
Budget per project	EUR 10 to 12 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	WW, P&P				
Keywords	Innovative value chains, technological risk reduction, Open Innovation Test Beds (OITB), cost reduction				
FTP comments					
FTP SIRA 2030 Challenges addressed	3C,E - 4D - 6 - 8A,B - 9A - 10A			**FTP relevance**	Low
				Starting TRL	5
				End TRL	7

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.

Destination 4: Digital and emerging technologies for competitiveness and fit for the Green Deal

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

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

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

- **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 potential124. 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-food125, forestry, inspection and maintenance, logistics, construction, manufacturing, etc.) and across multiple modalities (aerial, marine, ground, in-vivo and space).

The objective of this heading is to ensure autonomy for Europe in robotics, leading the way in research, development and deployment of world-class technologies.

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 (SRA126) 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 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.

As agreements with candidate Associated Countries are not yet in force, the eligibility to participate in such actions is limited for the moment to legal entities established in the EU, Norway and Iceland. However, in view of ensuring maximum excellence of R&I for the EU and to maintain EU's spirit of global openness, before opening these actions for applications, the eligibility to participate in these 12 actions will be extended to include legal entities established in (candidate) Associated Countries which provide assurances concerning the protection of EU's strategic assets, interests, autonomy or security. On the basis of the outcome of the discussions in the relevant configurations of the Horizon Europe Programme Committee, the Commission will reflect the changes in the work programme in full consistency with the decision establishing the Horizon Europe specific programme, especially through comitology procedures as foreseen in articles 13 and 14(4) of it.

- 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.

Call – Digital and emerging technologies for competitiveness and fit for the Green Deal 2021

European Innovation Leadership in Electronics

Topic ID and title	HORIZON-CL4-2021-DIGITAL-EMERGING-01-31: Functional electronics for green and circular economy (RIA)				
Budget	EUR 35 million	**Opening date**	22 June 2021	**Deadline 1**	21 October 2021
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	Organic electronics, next generation components, digital solutions, textiles, plastics, paper, life cycle				
FTP comments					
FTP SIRA 2030 Challenges addressed	9C,D			**FTP relevance**	Low/Medium
				Starting TRL	2-3
				End TRL	4-5

Expected Outcome:

Projects 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 technologies132 to address the challenges and opportunities associated with green and digital transformation. Eco-design principles133, 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.

Innovation in AI, Data and Robotics

<table>
<tr><td>Topic ID and title</td><td colspan="5">HORIZON-CL4-2021-DIGITAL-EMERGING-01-10: AI, Data and Robotics at work (AI, Data and Robotics Partnership) (IA)</td></tr>
<tr><td>Budget</td><td>EUR 22 million</td><td rowspan="2">Opening date</td><td rowspan="2">22 June 2021</td><td>Deadline 1</td><td>21 October 2021</td></tr>
<tr><td>Budget per project</td><td>EUR 3 to 5 million</td><td>Deadline 2</td><td>/</td></tr>
<tr><td>Type of action</td><td colspan="5">Innovation Actions (IA)</td></tr>
<tr><td>FTP subsector</td><td colspan="5">F&F, WW, P&P</td></tr>
<tr><td>Keywords</td><td colspan="5">Human-centric AI</td></tr>
<tr><td>FTP comments</td><td colspan="5"></td></tr>
<tr><td rowspan="3">FTP SIRA 2030 Challenges addressed</td><td colspan="3" rowspan="3">2B,D - 7</td><td>FTP relevance</td><td>Low</td></tr>
<tr><td>Starting TRL</td><td>3-5</td></tr>
<tr><td>End TRL</td><td>6-7</td></tr>
</table>

Expected Outcome:

Project 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 SSH140 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 dimension141 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.

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-ups142 will receive financial support to third parties, with a maximum of EUR 200 000 per third party143 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 platform144, Digital Industrial Platform for Robotics145, data platforms146 and, if necessary other relevant digital resource platforms. Communicable results from projects should be delivered to the most relevant of these platforms in order to enhance the European AI, Data and Robotics ecosystem through the sharing of results and best practice.

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.

Call – Digital and emerging technologies for competitiveness and fit for the Green Deal 2022

Innovation in AI, Data and Robotics

Topic ID and title	HORIZON-CL4-2022-DIGITAL-EMERGING-01-05: AI, Data and Robotics for Industry optimisation (including production and services) (AI, Data and Robotics Partnership)(IA)				
Budget	EUR 19 million	**Opening date**	23 November 2021	**Deadline 1**	5 April 2022
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	Artificial Intelligence (AI), production optimisation, competitiveness, environment sustainability, human-robot collaboration				
FTP comments					
FTP SIRA 2030 Challenges addressed	2B,D – cross-sectional			**FTP relevance**	Low
				Starting TRL	3-5
				End TRL	6-7

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, FAIR183 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 production184 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),

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-ups185 will receive financial support to third parties, with a maximum of EUR 200 000 per third party186 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 platform187, Digital Industrial Platform for Robotics188, data platforms189 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.

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, adaptative and trusted

Topic ID and title	HORIZON-CL4-2022-DIGITAL-EMERGING-01-07: Increased robotics capabilities demonstrated in key sectors (AI, Data and Robotics Partnership) (IA)				
Budget	EUR 36 million	**Opening date**	23 November 2021	**Deadline 1**	5 April 2022
Budget per project	EUR 6 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	adaptation and flexibility, human-robot interaction, robot-robot interactions, dull, dirty or strenuous tasks				
FTP comments					
FTP SIRA 2030 Challenges addressed	4A - 5 - 6B,C,F - 10A			**FTP relevance**	Low
				Starting TRL	3-5
				End TRL	6-7

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 SSH193 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.

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 SSH194, 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 intersectionality195 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 party196, 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.

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 platform197, Digital Industrial Platform for Robotics198, data platforms199 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.

Call – Digital and emerging technologies for competitiveness and fit for the green deal 2022

Graphene: Europe in the lead

Topic ID and title	HORIZON-CL4-2022-DIGITAL-EMERGING-02-19: 2D materials-based devices and systems for biomedical applications (RIA)				
Budget	EUR 6 million	**Opening date**	16 June 2022	**Deadline 1**	16 November 2022
Budget per project	EUR 6 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	cost reduction, efficacy of diagnostics or therapies, biocompatibility, bio-sensing, multidisciplinary teams				
FTP comments	Niche research on cellulose & nanocellulose-based materials and foams for healthcare				
FTP SIRA 2030 Challenges addressed	9A ,C,D – 10B			**FTP relevance**	Low
				Starting TRL	3-4
				End TRL	5

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.

Indirectly managed actions delegated to EUSPA

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

Topic ID and title	HORIZON-EUSPA-2021-SPACE-02-53: EGNSS applications for the Digital Age				
Budget	EUR 9,3 million	**Opening date**	2021 (indicative)	**Deadline 1**	2021-2022 (indicative)
Budget per project	EUR 2 to 3 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	Internet of Things (IoT), Artificial Intelligence (AI), Big Data, geo-tagging, mobile solutions, multiple sensors, cybersecurity, quantum, drones, 5G, Copernicus, augmented reality				
FTP comments					
FTP SIRA 2030 Challenges addressed	1A,B - 2B - 4 - 6F - 9D			**FTP relevance**	Low
				Starting TRL	/
				End TRL	7-9

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 optimization of multiple sensors. Proposals shall 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 shall enhance the security of location-based applications. Additionally, synergies with quantum can be leveraged as well.

- **Sharing economy- solutions for logistics, mobility services, goods and food. 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).

Cluster 5: Climate, Energy and Mobility[2]

Destination 2: Cross-sectoral solutions for the climate transition

This Destination covers thematic areas which are cross-cutting by nature and can provide key solutions for climate, energy and mobility applications. In line with the scope of cluster 5 such areas are batteries, hydrogen, communities and cities, early-stage breakthrough technologies as well as citizen engagement. Although these areas are very distinct in terms of challenges, stakeholder communities and expected impacts, they have their cross-cutting nature as a unifying feature and are therefore grouped together under this Destination.

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

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy49 by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*
- *D: Creating a more resilient, inclusive and democratic European society, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, and empowering all citizens to act in the green and digital transitions.*

It covers the following **impact areas**:

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

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

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

[2] Work Programme published by the European Commission on 15 June 2021

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

b. Increased efficiency of Europe's **cities' and communities'** energy, resource use and mobility patterns and cities' and communities' overall sustainability, thereby improving their climate-resilience and attractiveness to businesses and citizens in a holistic fashion. This also includes improved air and water quality, resilience of energy supply, intelligent mobility services and logistics, liveability and accessibility of cities, public health, comfortable, affordable zero emissions housing as well as the exploitation of relevant European technologies and knowledge (more detailed information below).

c. Facilitating the transformation to a climate neutral society, in line with the EU's 2050 climate targets, through more effectively **engaging and empowering citizens** to participate in the transition, from planning to decision-making and implementation (more detailed information below).

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

A competitive and sustainable European battery value chain

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

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

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

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

a. Increased global competitiveness of the European battery ecosystem through generated knowledge and leading-edge technologies in battery materials, cell design, manufacturing and recycling;

b. Accelerated growth of innovative, competitive and sustainable battery manufacturing industry in Europe;

c. Accelerated roll out of electrified mobility through increased attractiveness for citizens and businesses, offering lower price, better performance and safety, reliable operation of e-vehicles. Increased grid flexibility, increased share of renewables integration and facilitated self-consumption and participation in energy markets by citizens and businesses;

d. Increased overall sustainability and improved Life Cycle Assessment of each segment of the battery value chain. Developed and established innovative recycling network and technologies and in line with the March 2020 European Circular Economy Action Plan, accelerated roll-out of circular designs and holistic circular approach for funded innovations;

e. Increased exploitation and reliability of batteries though demonstration of innovative use cases of battery integration in stationary energy storage and vehicles/vessels/aircrafts (in collaboration with other partnerships).

Communities and cities

This work programme contains only a few activities. The bulk of activities related to communities and cities will be introduced during 2021 as an update to the Horizon Europe work programme 2021, once the preparatory phase of the Horizon Europe Missions has been concluded.

Emerging breakthrough technologies and climate solutions

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

Relevant topics supported under this Destination do not duplicate activities supported under Pillars I or III, but focus on emerging technologies that can enable the climate transition and follows at the same time a technology-neutral bottom up approach and the support of key technologies that are expected to support achieving climate neutrality. Research in this area

is mostly technological in nature but should also where relevant be accompanied by assessments of environmental impact, social and economic impacts, and possible regulatory needs as well as activities to support the creation of value chains and to build up new ecosystems of stakeholders working on breakthrough technologies.

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

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

Citizens and stakeholder engagement

The transition to climate-neutral economies and societies by 2050 is the defining challenge of this century. The challenge is not just technical: it calls for wide-ranging societal transformations and the adaptation of lifestyles and behaviours. Engaging citizens and stakeholders is therefore critical for the success of the European Green Deal, as is making greater recourse to the Social Sciences and Humanities (SSH), alongside the Scientific, Technical, Engineering and Mathematical (STEM) disciplines.

The topics under this section do not stand alone but aim to complement and support the broader integration ("mainstreaming") of citizen and stakeholder engagement as well as the social sciences and humanities (SSH) across the whole Horizon Europe programme map and particularly Cluster 5.

The main expected impacts to be generated by topics targeting citizen and stakeholder engagement under this Destination are:

- A better understanding of the societal implications of the climate transition, including its distributional repercussions;
- More effective policy interventions, co-created with target constituencies and building on high-quality policy advice;
- Greater societal support for transition policies and programs, based on greater and more consequential involvement of those most affected.

Call – Cross-sectoral solutions for the climate transition 2021

Emerging breakthrough technologies and climate solutions

Topic ID and title	HORIZON-CL5-2021-D2-01-08: Emerging technologies for a climate neutral Europe				
Budget	EUR 20 million	**Opening date**	24 June 2021	**Deadline 1**	19 October 2021
Budget per project	EUR 2,5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	high-risk technologies, high return technologies, net GHG neutral EU economy, technological feasibility, decarbonised transport, fuel cells, energy generators, energy storage (not batteries), negative GHG emissions				
FTP comments					
FTP SIRA 2030 Challenges addressed	10			**FTP relevance**	Low
				Starting TRL	/
				End TRL	4

Expected Outcome:

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

- Available high-risk/high return technologies for a transition to a net greenhouse gas neutral EU economy by 2050.
- Knowledge and scientific proofs of the technological feasibility of the concept.
- Environmental, social and economic benefits to contribute to R&I strategy and policy forecast.
- Establishing a solid long term dependable European innovation base.

Scope:

The proposal is expected to address one of the following areas:

- Decarbonised, efficient, effective, and safe Transport;
- Fuel cells;
- Efficient energy generators;
- Energy distribution;
- Energy storage;

- Negative GHG emissions.

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

- Material research;
- Renewable energy technologies and renewable hydrogen production are addressed under HORIZON-CL5-2021-D3-02-02;
- Batteries

The proposal should address the validation of its concept to TRL 4, presenting a robust research methodology and activities, establishing the technological feasibility of the proposed concept. The methodology should include proper assessment of the environmental, social and economic benefits, and consider transfers of developments in sectors other than energy whenever relevant. These interdisciplinary aspects may provide ideas, experiences, technology contributions, knowledge, new approaches, innovative materials and skills. The applications of those concepts can also be proposed for various sectors. Economic benefits could be for example technology cost reduction, job creations, new businesses and more efficient motors and generators.

Proposals may consider the following areas:

- Technologies providing the possibility of multi-fuel integration and/or the potential for the transversal;
- Intersectorial decarbonization;
- Concepts targeting hard-to-decarbonize sectors and energy-intensive applications, such as road/rail/maritime transport or energy generation though thermal power generators;
- Flexibility in terms of its scalability to different power/energy demands;
- Compatibility with local or distributed energy production layouts;
- Use of already available industrial processes and raw materials for easy TRL upgrading and final transfer to mass production.

In developing its concept the proposal is expected to address the following related aspects:

- Lower environmental impact (e.g. on climate change, pollution and biodiversity) quantified based on Life Cycle Assessment (LCA) framework;

- Better resource efficiency (materials, geographical footprints, water, etc…) than current commercial technologies;
- Barriers to the deployment of such technologies, including issues related to social acceptance or resistance to new energy technologies, related socioeconomic and livelihood issues globally;
- Prospective life cycle approach to be done with the relevant information that can be gathered at such TRL level.

Destination 3: Sustainable, secure and competitive energy supply

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

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

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

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy69 by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations;*

It covers the following **impact areas**:

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

The **expected impact**, in line with the Strategic Plan, is to contribute to "*More efficient, clean, sustainable, secure and competitive energy supply through new solutions for smart grids and energy systems based on more performant renewable energy solutions*", notably through

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

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

iii. Accelerating the development of **Carbon Capture, Use and Storage (CCUS)** as a CO2 emission mitigation option in electricity generation and industry applications (including also conversion of CO2 to products) (more detailed information below).

Fostering the European global leadership in affordable, secure and sustainable renewable energy technologies

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

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

Synergies with activities in cluster 4 are possible for integrating renewable energy technologies and solutions in energy consuming industries. Complementarities with cluster 6 concern mainly biomass-related activities.

In line with the “do not harm” principle for the environment, actions for all renewable energy technologies aim to also improve the environmental sustainability of the technologies, delivering products with reduced greenhouse gas emissions and improved environmental

performance regarding water use, circularity, pollution and ecosystems. In particular, for biofuels and bioenergy improving the environmental sustainability is associated to the biomass conversion part of the value chain and the quality of the product, while air pollution associated to combustion in engines falls in the scope of other parts of the WP.

The main impacts to be generated by topics targeting the renewable energy technologies and solutions under this Destination are:

a. Availability of disruptive renewable energy and renewable fuel technologies and systems in 2050 in order to accelerate the replacement of fossil-based energy technologies.

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

c. De-risking of renewable energy and fuel technologies with a view to their commercial exploitation and net zero greenhouse gas emissions by 2050.

d. Better integration of renewable energy and renewable fuel-based solutions in energy consuming sectors.

e. Reinforced European scientific basis and European export potential for renewable energy technologies through international collaboration (notably with Africa in renewable energy technologies and renewable fuels and enhanced collaboration with Mission Innovation countries).

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

g. More effective market uptake of renewable energy and fuel technologies.

Energy systems, grids and storage

Efficient and effective network management is the key to the integration of renewables in an efficient way that ensures cost-effectiveness and affordability, security of supply and grid stability. Real time monitoring and optimisation are necessary to increase the flexibility, through solutions such as storage, demand response or flexible generation among others, to integrate higher shares of variable renewable energy. Exploiting synergies between electricity, heating and cooling networks, gas networks, transport infrastructure and digital infrastructure will be crucial for enabling the smart, integrated, flexible, green and sustainable operation of the relevant infrastructures. Besides hydrogen and batteries (addressed elsewhere), R&I in other storage technologies, in particular thermal storage but

also electrochemical, chemical, mechanical and electrical storage solutions is necessary to create a set of flexibility options.

Activities on energy systems, grids and storage under this Destination will primarily focus on the systemic aspects to enhance the flexibility and resilience of the system, in particular: integrated energy system planning and operation, engaging consumers and providing new services, electricity system reliability and resilience, storage development and integration and green digitalisation of the energy system.

Moreover, the role of citizens and communities is key when it comes to making the flexibility at appliance level available for the grid. Related to this, the inclusion of social sciences and humanities (SSH) where relevant is essential to build the social acceptance of new energy technologies and increase participation of consumers in energy markets.

All projects will contribute to an increased capacity of the system to integrate renewable energy sources and less curtailment at transmission and distribution level. The main expected impacts are:

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

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

c. Enhance consumer satisfaction and increased system flexibility thanks to enabling consumers to benefit from data-driven energy services and facilitating their investment and engagement in the energy transition, through self-consumption, demand response or joint investments in renewables (either individually or through energy communities or micro-grids).

d. Improved energy storage technologies, in particular heat storage but also others such as electrochemical, chemical, mechanical and electrical.

e. Foster the European market for new energy services and business models as well as tested standardised and open interfaces of energy devices through a higher degree of interoperability, increased data availability and easier data exchange among energy companies as well as companies using energy system data.

f. More effective and efficient solutions for transporting off-shore energy thanks to new electricity transmission technologies, in particular using superconducting technologies,

power electronics and hybrid Alternate Current – Direct Current grid solutions as well as MT HVDC (Multi Terminal High Voltage Direct Current) solutions.

Carbon capture, utilisation and storage (CCUS)

CCUS will play a crucial role in the EU Green Deal for the transition of energy-intensive industries and the power sector towards climate neutrality. Supporting R&I for CCUS will be particularly important in those industries where other alternatives do not yet exist like the cement industry. This will be highly relevant towards 2050, when most electricity will be coming from renewables, but the need to tackle the process emissions from industry will continue. If CCUS is combined with sustainable biomass, it could create negative emissions.

Low carbon hydrogen from natural gas with CCUS could also play a significant role in industrial climate neutrality, in the transition towards full use of hydrogen from renewable sources, in particular in industries such as steel making, chemicals, or refining where large quantities of hydrogen are needed. CCUS would enable early, clean hydrogen at scale. The hydrogen infrastructure built for clean hydrogen with CCUS could be also shared by hydrogen from renewable sources. It is thus important to develop CCUS for industrial clusters, including aspects of system planning, shared infrastructure solutions such as buffer storage, shared CO2 and hydrogen transportation and infrastructure optimisation for CCS and CCU.

Demonstration of the full CCUS chain is needed in the EU, with special emphasis on the reduction of the energy penalty and cost of capture and on ascertaining safe storage. Under the EU Strategic Energy Technology Plan (SET Plan) ambitious R&I targets have been set in agreement with the sectorial stakeholders. The focus is on CO2 storage appraisal, cost-reductions, new technologies and proliferation of pilots and demonstrators.

Synergies with cluster 4 exist on the use of CO2 (please see topic "HORIZON-CL4-2022-TWIN-TRANSITION-01-11: Valorisation of CO/ CO2 streams into added-value products of market interest (IA)").

The main impacts to be generated by topics targeting the renewable energy technologies and solutions under this Destination are:

a. Accelerated rollout of infrastructure for CCUS hubs and clusters.

b. Updated authoritative body of knowledge on connecting industrial CO2 sources with potential 'bankable storage sites, providing greater confidence for decision makers and investors.

c. Proven feasibility of integrating CO2 capture, CO2 storage and CO2 use in industrial facilities. Demonstrating these technologies at industrial scale shall pave the way for subsequent first-of-a-kind industrial projects.

d. Reduced cost of the CCUS value chain, with CO2 capture being still the most relevant stumbling block for a wider application of CCUS.

e. Adequate frameworks for Measurement, Monitoring and Verification (MMV) for storage projects, to document safe storage and for public acceptance of the technology.

Call – Sustainable, secure and competitive energy supply 2021

Global leadership in renewable energy

Topic ID and title	HORIZON-CL5-2021-D3-03-09: Carbon-negative sustainable biofuel production				
Budget	EUR 15 million	**Opening date**	02 September 2021	**Deadline 1**	23 February 2022
Budget per project	EUR 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P + Bioenergy				
Keywords	bioenergy efficiency, bioenergy sustainability, sustainable biomass resource utilization, negative emissions, minimize carbon waste, biogenic effluent gas emissions inhibition, recycling, biogenic carbon storage, Life Cycle Analysis (LCA)				
FTP comments					
FTP SIRA 2030 Challenges addressed	10A			**FTP relevance**	Low
				Starting TRL	/
				End TRL	4-5

Expected Outcome:

Reusing or inhibiting biogenic effluent gases from biofuel production in the same process, increases the biomass conversion efficiency and sustainability potential and the overall resource and energy efficiency of the biomass utilization. Improving such integration will contribute to increase the biofuel technology competitiveness and acceptance and advance the European leadership and global role in the area of sustainable biofuels.

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

- Increase bioenergy efficiency and sustainability.
- Increase sustainable biomass resource utilization.
- Generate negative emissions from biofuel production.

Scope:

Proposals should develop cost-effective solutions to minimize carbon waste in sustainable biofuel production processes by inhibiting biogenic effluent gas emissions or incorporating biological and/or chemical/other capture of the biogenic effluent gas emissions from the process and use it as appropriate either for separate in-situ downstream synthesis of renewable fuels of biological origin, or integrate it in the sustainable biofuel production through recycling. Proposals should also include an innovative approach for biogenic carbon storage, through for example integrating production of biochar and using it as soil

amendment to enhance organic carbon content and functionality of soil, as well as a means to sequester carbon into the soil. Synergies with renewable hydrogen production should be developed by incorporating it as appropriate in the sustainable biofuel production to compensate for additional needs in hydrogen, increase overall biomass conversion efficiency, minimize the biogenic carbon waste and reduce the fossil carbon footprint of the biofuel production. The overall GHG emissions should be assessed on the basis of a Life Cycle Analysis for proving negative GHG emissions and higher sustainability potential of biofuel production when reusing biogenic effluent gases in-situ, along with addressing socioeconomic aspects.

Topic ID and title	HORIZON-CL5-2021-D3-03-16: Innovative biomethane production as an energy carrier and a fuel				
Budget	EUR 20 million	**Opening date**	02 September 2021	**Deadline 1**	23 February 2022
Budget per project	EUR 10 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	P&P				
Keywords	biomethane production, cost-effectiveness, conversion technology, gas market, Strategic Energy Technology (SET) Plan Action 8, sustainable biomass, biogenic wastes gasification, circularity,				
FTP comments					
FTP SIRA 2030 Challenges addressed	10A			**FTP relevance**	Low
				Starting TRL	/
				End TRL	6-7

Expected Outcome:

Biomethane is a renewable substitute of natural gas, which can provide energy storage capability and be a flexible renewable energy carrier to be fed to the existing gas grid if reaching quality standards at an affordable price.

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

- Increase cost-effectiveness of the conversion in biomethane production.
- Diversify the conversion technology basis for biomethane production.
- Contribute to market up-take of biomethane related technologies in the gas market.
- Contribute to the priorities of the SET Plan Action 8.

Scope:

Proposals will demonstrate cost-effective and innovative biomethane production through thermochemical, biochemical, chemical, electrochemical, biological pathways including sustainable biomass and biogenic wastes gasification, CO2 effluents from anaerobic digestion or fermentation processes combined with renewable hydrogen or water. The biomethane production should be optimized to improve production efficiency, reduce cost, minimize GHG emissions and increase sustainability in a circularity approach for energy and material above conventional technologies of biogas upgrading to biomethane. All demonstrators should be fully and transparently documented, to ensure replicability, up-scaling and to assist future planning decisions. Demonstrating advanced technologies for efficient production at scale of biomethane will contribute to facilitate the market introduction of the biomethane technologies and the substitution of natural gas in the gas

grid. This is the basis for penetration of biomethane in the energy and the transport energy systems, in particular for gas consuming sectors. It supports the European Green Deal and climate and energy targets for 2030 and the net zero greenhouse gas emissions by 2050, while supporting the EU goals for energy independence and competitive sustainable growth.

Call – Sustainable, secure and competitive energy supply 2022

Global leadership in renewable energy

Topic ID and title	HORIZON-CL5-2022-D3-01-01: Demonstration of cost-effective advanced biofuel technologies utilizing existing industrial plants				
Budget	EUR 20 million	**Opening date**	14 October 2021	**Deadline 1**	26 April 2022
Budget per project	EUR 10 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	P&P				
Keywords	capital expenses (CAPEX) reduction, operational expenses (OPEX) reduction, de-risk technology, Strategic Energy Technology (SET) Plan Action 8, transport, first generation biofuels, socio-economic benefits, sustainable biomass feedstock, paper mill industry, circularity, digitalization				
FTP comments	advanced biofuel technologies, transformation of existing plants, paper mill industry				
FTP SIRA 2030 Challenges addressed	10A,C			**FTP relevance**	Medium/High
				Starting TRL	/
				End TRL	6-7

Expected Outcome:

The cost-effective integration of advanced biofuel technologies in existing industrial plants will contribute to increase the competitiveness of these technologies and overcome the costly scaling-up of advanced biofuel production which requires heavy new infrastructure and investments and impedes their capacity building. It will thus allow high penetration of advanced biofuels in the transport energy system, in particular for hard to electrify sectors like aviation and maritime. Project results are expected to contribute to all of the following expected outcomes:

- Reduce capital and operational expenses (CAPEX and OPEX) of advanced biofuel production facilities.
- De-risk technology, boost scale-up of advanced biofuels and contribute to their market up-take.
- Contribute to the priorities of the SET Plan Action 8.
- Respond to short and medium term needs for renewable fuels in transport.
- Create win-win solutions for advanced biofuel production and conventional industrial phasing out plants, e.g., first generation biofuels, associated with socio-economic benefits.

Scope:

Proposals should demonstrate cost-efficient advanced biofuel technologies which improve the economic viability of the advanced biofuel production. This should be done through innovative transformation of existing plants to incorporate production of advanced biofuels from non-food/feed sustainable biomass feedstock into existing processes, e.g., first generation biofuel plants, paper mill industry, waste treatment plants, oil-refineries, petrochemical industry, etc. Integration of advanced biofuel processing should be done with new and innovative installations and it should be optimized implementing a circularity approach for energy and material, as well as digitalization as appropriate, e.g. by using sensors, smarter equipment, algorithms etc., to increase the efficiency, cost-effectiveness and performance of the final plant. Economic advantages in terms of both capital and operational expenditure for commercialization of advanced biofuels through transformation, as well as socio-economic benefits for phasing-out industries including the impact on current first generation biofuel sites should be addressed. Proposals should provide information about the expected economic improvements and the potential of full transformation to advanced biofuel plants as appropriate. All demonstrators should be fully and transparently documented, to ensure replicability, up-scaling and to assist future planning decisions.

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.

Call – Sustainable, secure and competitive energy supply 2022

Global leadership in renewable energy

Topic ID and title	HORIZON-CL5-2022-D3-02-01: Digital solutions for defining synergies in international renewable energy value chains				
Budget	EUR 9 million	**Opening date**	26 May 2022	**Deadline 1**	27 October 2022
Budget per project	EUR 3 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P + Bioenergy				
Keywords	renewable energy, renewable fuels, value chains, digital breakthrough, global renewable energy share, international collaboration, system component's reliability, novel digital solutions, data analysis, diagnosis and fault detection				
FTP comments					
FTP SIRA 2030 Challenges addressed	10C			**FTP relevance**	Low
				Starting TRL	/
				End TRL	5

Expected Outcome:

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

- Advance the European and global scientific basis, European leadership and global role in the area of renewable energy and renewable fuels and related energy value chains while creating evidence for policy making by developing novel digital solutions.
- Provide digital breakthrough solutions for promoting the increase of the global renewable energy share.
- Reinforce the European scientific basis through international collaboration while increasing the potential to export European renewable energy technologies and ensuring political priorities in the context of sustainable global energy value chains.
- Improve reliability of system components, advanced and automated functions for data analysis, diagnosis and fault detection, forecasting and model-predictive control frameworks, ancillary services for the stability of the network; maintenance planning and/or reporting.

Scope:

Development of novel real time and open data monitoring and/or simulation solutions (e.g. including digital twins) for sustainable energy production and consumption, predictive modelling and artificial intelligence for the analysis of international renewable energy value

chains and for internationally aligned decision-making in cooperation with international partners from Mission Innovation Countries. To ensure trustworthiness, wide adoption by user communities and support EU policy-makers, actions should promote the highest standards of transparency and openness, going well beyond documentation and extending to aspects such as assumptions, models and data related to renewable energy and fuels.

Topic ID and title	HORIZON-CL5-2022-D3-02-08: Demonstration of complete value chains for advanced biofuel and non-biological renewable fuel production				
Budget	EUR 20 million	**Opening date**	26 May 2022	**Deadline 1**	27 October 2022
Budget per project	EUR 10 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	P&P + Bioenergy				
Keywords	cost-effective sustainable value chains, de-risk technology, Strategic Energy Technology (SET) Plan Action 8, energy, transport, feedstock, residues, wastes				
FTP comments					
FTP SIRA 2030 Challenges addressed	10A,B			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	6-7

Expected Outcome:

Complete value chains for advanced biofuels and renewable fuels of non-biological origin provide a systemic understanding of the value created and the constraints in individual chain steps. Demonstrating such complete value chains will contribute to increase the competitiveness of their technologies and foster their commercialization to allow high penetration of advanced biofuels and renewable fuels of non-biological origin in the energy and transport energy system, in particular for hard to electrify sectors.

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

- Build a portfolio of complete value chains for advanced biofuels and renewable fuels of non-biological origin.
- De-risk technology, boost the scale-up of advanced biofuels and non-biological origin renewable fuels.
- Contribute to the priorities of the SET Plan Action 8.
- Respond to short and medium term needs for renewable fuels in energy and transport.
- Improve sustainability and security of the value chains.

Scope:

Proposals should demonstrate innovative and cost effective sustainable value chains for advanced biofuels or synthetic renewable fuels of non-biological origin (other than for hydrogen as a final product), over the entire cycle from feedstock to end use. Any sustainable biomass feedstock including residues and wastes, or biogenic CO2 or industrial CO2 and

renewable hydrogen, as well as input energy to the conversion should be addressed. Pathways which are biochemical, thermochemical, biological, chemical, electrochemical or combinations of them should be considered. Proposals should aim at improved performance in terms of increasing the efficiency and sustainability and reducing the cost, while evidencing the value creation along the value chain steps. Complete value chains may address any relevant end use.

Call – Sustainable, secure and competitive energy supply

Global leadership in renewable energy

Topic ID and title	HORIZON-CL5-2022-D3-03-02: Best international practice for scaling up sustainable biofuels				
Budget	EUR 9 million	**Opening date**	6 September 2022	**Deadline 1**	10 January 2023
Budget per project	EUR 3 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P + Bioenergy				
Keywords	Sustainable biofuels value chains, cost-effective production, large-scale production, skill development, knowledge sharing, international cooperation, best practices, Life Cycle Analysis (LCA), international cooperation				
FTP comments	sustainability assessment of sustainable biofuels value chains, Mission Innovation Challenge n4 Sustainable Biofuels, Strategic Energy Technology (SET) Plan Action 8, international cooperation				
FTP SIRA 2030 Challenges addressed	10D			**FTP relevance**	Medium/Low
				Starting TRL	/
				End TRL	4-5

Expected Outcome:

The need of including sustainable biofuels in a transformed integrated energy system is recognized worldwide. Enhancing the European global role in this area will increase the potential to export European renewable fuel technologies into global developing markets, and improve sustainability of biofuel value chains worldwide while supporting the EU goals for climate change mitigation in 2030 and 2050.

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

- Build global knowledge for the scaling-up and the sustainability assessment of sustainable biofuels value chains.
- Contribute to cost-effective and more sustainable large-scale production of sustainable biofuels.
- Contribute to Mission Innovation Challenge n°4 Sustainable Biofuels158.
- Contribute to the SET Plan Action 8 Bioenergy and Renewable Fuels for Sustainable Transport.
- Accelerate capacity building for sustainable biofuels in the world.
- Develop networks for skill development and knowledge sharing in sustainable biofuels value chains worldwide.

Scope:

Proposals will aim at fostering international cooperation to develop best practices and concepts along the entire value chain for accelerating the scale-up of sustainable biofuels worldwide. Scaling up sustainable biofuels is a global challenge in terms of environmental, social, and economic sustainability, which can benefit from international collaboration and knowledge exchange. Proposals should address systemic constraints and opportunities for scaling up complete value chains of sustainable biofuels and propose solutions. Any sustainable non-food/feed biomass feedstock and any innovative technology or combinations of them should be considered. Proposals should enhance overall cost-effectiveness and sustainability of large scale production of sustainable biofuels based on Life Cycle Analysis addressing social, economic and environmental aspects. International cooperation with Mission Innovation countries is expected.

Topic ID and title	HORIZON-CL5-2022-D3-03-06: Efficient and low-emission technologies for industrial use of combustion and gasification systems from low-value biogenic residues and wastes				
Budget	EUR 10 million	**Opening date**	6 September 2022	**Deadline 1**	10 January 2023
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	bioenergy integration into industrial settings, policy making evidence, feedstock diversification, technological performance, cost-reduction, circularity, supply security, biomass combustion, biomass gasification, emissions reduction, biofuel flexible systems				
FTP comments					
FTP SIRA 2030 Challenges addressed	10			**FTP relevance**	Low
				Starting TRL	/
				End TRL	5

Expected Outcome:

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

- Advance the European scientific basis, technology base, leadership and global role in the area of bioenergy integration into industrial settings while creating evidence for policy making;
- Increased feedstock diversification and better technological performance leading to cost-reduction of bioenergy with positive effects on renewables' penetration, circularity and security of supply;
- Reduced emissions and increased environmental and socio-economic sustainability of biomass combustion and gasification and bioenergy value chains.

Scope:

Development of technologies for optimization of advanced biofuel flexible systems regarding upstream multi-feedstock, logistics, feeding, ash management, combustion or gasification processes and effluent emissions and their effective integration into industrial process energy environment through efficient and low-emission technologies for industrial use of combustion and gasification systems from low-economic value, but fully sustainable biogenic residues and wastes.

Destination 4: Efficient, sustainable and inclusive energy use

This Destination addresses activities targeting the energy demand side, notably a more efficient use of energy as regards buildings and industry.

Demand side solutions and improved energy efficiency are among the most cost effective ways to support the transition to climate neutrality, reduce pollution and raw materials use, to create inclusive growth and employment in Europe, to bring down costs for consumers, to reduce our import dependency and redirect investments towards smart and sustainable infrastructure. The transition to a decentralised and climate neutral energy system will greatly benefit from the use of digital technologies which will enable buildings and industrial facilities to become inter-active elements in the energy system by optimising energy consumption, distributed generation and storage and vis-à-vis the energy system. They will also trigger new business opportunities and revenue streams for up-graded, innovative energy services which valorise energy savings and flexible consumption.

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

- *C: Making Europe the first digitally enabled circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems;*
- *A: Promoting an open strategic autonomy161 by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations.*

It covers the following **impact areas**:

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

The **expected impact**, in line with the Strategic Plan, is to contribute to the "*Efficient and sustainable use of energy, accessible for all is ensured through a clean energy system and a just transition*", notably through

a. Technological and socio-economic breakthroughs for achieving climate neutrality and the transition to zero pollution of the **building stock** by 2050, based on inclusive and people-centric R&I (more detailed information below).

b. b. Increased energy efficiency in **industry** and reducing industry's Greenhouse Gas (GHG) and air pollutant emissions through recovery, upgrade and/or conversion of industrial excess (waste) heat and through electrification of heat generation (more information below).

Other Horizon Europe Clusters include topics and activities that can be relevant to this Destination, e.g. in order to seek synergies. These include (but are not limited to) the following:

Cluster 2:

- Destination 2 – Innovative Research on the European Cultural Heritage and the Cultural and Creative Industries. That Destination is most relevant for the topics which scope addresses heritage buildings.
- Destination 3 - Innovative Research on Social and Economic Transformations. That Destination is most relevant for the social innovation items included in some of the topics.

Cluster 3:

- Destination 4 – Increased Cybersecurity. This potential link is most relevant for the topics that address smart buildings and digitalisation of buildings.
- Destination 5 – A Disaster-Resilient Society for Europe. This potential link can be relevant for the topics that address the resilience of the building stock.

Cluster 4: the whole cluster is relevant, in particular Destination 1 – Climate Neutral, circular and digitised production, which is highly relevant for all topics on buildings (e.g. for the digitalisation of construction / renovation workflows).

Cluster 6:

- Destination 3 – Circular economy and bioeconomy sectors and Destination 4 – Clean environment and zero pollution. This potential link is relevant for all topics, in particular those that address sustainable renovation of buildings.

Beyond Horizon Europe, other programmes include some components with which synergies and complementarities can be found. For instance, the Clean Energy Transition and Circular Economy sub-programmes under LIFE can contribute to the market uptake of the innovation delivered under this Destination. The Digital Europe programme includes actions that can be relevant to consider in relation to the topics that entail the development or use of (big) data approaches.

Highly energy-efficient and climate neutral European building stock

Topics under this Destination targeting highly energy-efficient and climate-neutral European building stock focus on both, the energy challenge in buildings and, more broadly, the transformation of the built environment towards more sustainable living.

In line with the new European Bauhaus aiming to "bring the European Green Deal to life in an attractive, and innovative and human-centred way", the sustainable built environment should go beyond merely improving the energy and resource efficiency of buildings and also include a qualitative, aesthetic and human dimension. At the intersection of science, technology and the arts, new creative design and architectural solutions should be developed to ensure the sustainable renovation of the existing European building stock for the well-being of its users. In particular the renovation or adaptive reuse of historical and heritage buildings and sites needs to embrace quality principles to safeguard the cultural values of Europe's historical environment and local architectural identity.

Topics targeting energy efficiency in buildings under this Destination seek to achieve the following impacts:

- More energy efficient building stocks supported by an accurate understanding of buildings performance in Europe and of related evolutions.
- Building stocks that effectively combine energy efficiency, renewable energy sources and digital and smart technologies to support the transformation of the energy system towards climate neutrality.

Addressing the broader transformation of the built environment, though, requires a larger involvement of all players across the built environment value chain and throughout building life cycle. To this end, a co-programmed European Partnership on a people-centric, sustainable built environment has been set up (Built4People) to develop holistic R&I for an effective transition to sustainability. All Horizon Europe R&I actions addressing the challenges related to the buildings and construction sector will contribute to achieving the Built4People Partnership goals and will benefit from the coordinated approach within the community of its partners and stakeholders. Topics contributing to the implementation of the Built4People European Partnership seek to achieve the following impacts:

- Higher buildings' performance with lower environmental impacts through increased rates of holistic renovations.
- Higher quality, more affordable built environment preserving climate and environment, and safeguarding cultural heritage and ensuring better living conditions.

Industrial facilities in the energy transition

Topics on industrial facilities in the energy transition supported under this Destination focus on thermal energy management in industry. The bulk of R&I activities related to industry is however supported under Cluster 4 “Digital, Industry and Space”.

Call – Efficient, sustainable and inclusive energy use 2021

Industrial facilities in the energy transition

Topic ID and title	HORIZON-CL5-2021-D4-01-04: Full-scale demonstration of heat upgrade technologies with supply temperature in the range 90 - 160°C				
Budget	EUR 16 million	**Opening date**	24 June 2021	**Deadline 1**	19 October 2021
Budget per project	EUR 8 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	P&P				
Keywords	industrial heat upgrade systems, circularity, neighbouring plants, heating networks, CO2 emissions reduction, energy savings				
FTP comments	Heat Pump				
FTP SIRA 2030 Challenges addressed	6A			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	7-8

Expected Outcome:

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

- Demonstration at full scale (0.5 – 10 MWth) of industrial heat upgrade systems to supply various industrial processes with useful heat in the (sink) temperature range of 90 – 160 °C, extracted from renewable heat sources (e.g. solar thermal), ambient heat or industrial waste heat.
- Scaling up and improvement of the economic and technical performances of heat upgrade in order to cover more industrial processes with special attention to integration and adaptation to existing/improved processes.
- Demonstration of business models and contractual agreements in the cases of use of the upgraded heat within the industrial plant, in other neighbouring plants or heating networks, as part of the Hubs4circularity approach, identifying also potential regulatory barriers.
- Better awareness of the challenges and benefits of heat upgrade in the relevant industrial sectors.

Scope:

This topic aims to satisfy the need for low temperature heat in the relevant industrial sectors, by upgrading lower temperature heat flows, including from renewable heat sources,

ambient heat or industrial excess (waste) heat, as a cost-efficient way to improve energy efficiency and reduce the GHG emissions.

Heat upgrade technologies exist, such as for example heat pumps, but their size needs to be scaled-up and their cost needs to be reduced, notably by improving their performances, and their operation needs to be demonstrated in various industrial contexts, in order to ensure their wide deployment. The optional integration of renewable heat sources (e.g. solar thermal) as the input heat flow to be further upgraded, is in scope.

In order to reach this goal all the following development areas need to be covered:

- Identify the target industrial processes which would benefit from this technology, as excess (waste) heat sources and as users (heat sinks); assess the impacts of these applications in terms of energy savings and GHG and air pollutant emissions reductions in the EU (and Associated States, if data are available), so as to maximise the impact and coverage of the most promising applications in the subsequent optimisation and demonstration steps. A preliminary analysis of the technico-economic feasibility and impact of the proposed heat upgrade process is expected already in the proposal.

- Optimise the heat upgrade system to improve its economic and technical performances in terms of: sink output temperature range (90 to 160°C); temperature increase between sink inlet and sink outlet temperatures; temperature spread between source and sink temperatures; flexibility to source input temperature variations; higher sink thermal power; higher coefficient of performance; bigger size; lower CAPEX (equipment) and operational costs (higher efficiency and lower maintenance).

- Development/improvement of design tools at components and system levels.

- Integration and long term full-scale demonstration of the system in an industrial application in at least one industrial sector.

- Technical and economical life cycle assessment of heat upgrade systems adapted for at least 4 industrial sectors, to demonstrate economic viability, define business cases and exploitation strategy.

- Assess the potential impact in CO2 emissions reduction (Mton CO2/a) and energy savings (TWh/a) in EU27 and (if data are available) in the Associated States, of using heat upgrade systems in the relevant industrial sectors, taking into account not only the thermal energy temperature and volumes needed by the relevant sectors but also the temperature lift capabilities, and the availability of ambient or waste heat sources.

The supply temperature ranges to be considered for the impact assessment are: <100°C, 100-200°C and >200°C. Evaluate the potential impact at global level by extrapolation. In case several projects are funded under this call, the results of this assessment should be compared with the other projects and harmonised.

- Identify the potential barriers to the deployment of heat upgrade and use due to the local regulatory framework in the EU Member States and Associated Countries.
- Disseminate the technical and economic benefits, notably (but not only) to the communities of the relevant Horizon Europe private-public partnerships.
- Given the transversal nature of the technology, the potential for transferring the technology to the building heating sector, including district heat networks, should be assessed and disseminated.

Call – Efficient, sustainable and inclusive energy use 2022

Industrial facilities in the energy transition

Topic ID and title	HORIZON-CL5-2022-D4-01-04: Development and pilot demonstration of heat upgrade technologies with supply temperature in the range 150-250°C				
Budget	EUR 10 million	**Opening date**	28 April 2022	**Deadline 1**	6 September 2022
Budget per project	EUR 3 to 5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	P&P				
Keywords	heat upgrade systems, renewable heat sources, industrial waste heat				
FTP comments					
FTP SIRA 2030 Challenges addressed	10C			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	5

Expected Outcome:

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

- Validate the technical feasibility of industrial heat upgrade systems capable of supplying various industrial processes with useful heat in the (sink) temperature range of 150 – 250 °C from renewable heat sources (e.g. solar thermal), ambient heat or industrial waste heat.
- Development and demonstration at pilot scale (5 – 200 kWth).
- Better awareness of the challenges and benefits of heat upgrade in the relevant industrial sectors.

Scope:

This topic aims to satisfy the need for low-medium temperature heat in the relevant industrial sectors, by upgrading lower temperature heat flows, including from renewable heat sources, ambient heat or industrial excess (waste) heat, as a cost-efficient way to improve energy efficiency and reduce the GHG emissions.

Available heat upgrade technologies, such as for example heat pumps, are limited to supply (sink) temperatures of 150°C. Innovative heat upgrade technologies have the potential to extend the temperature range up to 250°C, which would allow to cover more industrial applications.

In order to reach this goal all the following development areas need to be covered:

- Identify the target industrial processes which would benefit from this higher temperature heat upgrade technology, as excess (waste) heat sources and as users (heat sinks); make a preliminary assessment of the potential impacts of these industrial applications in terms of energy savings and GHG and air pollutant emissions reductions in the EU (and Associated States, if data are available), so as to maximise the impact and coverage of the most promising applications in the subsequent development step; estimate by extrapolation the benefits at global level. A preliminary analysis of the feasibility and GHG emissions reduction impact, of the proposed heat upgrade process is expected already in the proposal.

- Develop one or more heat upgrade technologies to raise the sink output temperature to the range 150 to 250°C. If needed investigate in new working fluids. Optimise the technical performances in terms of: temperature increase between sink inlet and sink outlet temperatures; temperature spread between source and sink temperatures; flexibility to source input temperature variations; higher sink thermal power potential; higher coefficient of performance.

- Integration and demonstration of at least one system at pilot scale, in conditions, as far as practical, similar to real industrial environment. The optional integration of renewable heat sources (e.g. solar thermal) as the input heat flow to be further upgraded, is in scope.

- Make a preliminary estimation of the future equipment cost for at least two industrial applications, to evaluate its economic potential; define an exploitation strategy.

- Dissemination of the technical and economic benefits, notably (but not only) to the communities of the relevant Horizon Europe private-public partnerships.

Cluster 6 : Food, Bioeconomy, Natural Resources, Agriculture and Environment[3]

Destination 1: Biodiversity and ecosystem services

The EU biodiversity strategy for 2030 is a cornerstone of the European Green Deal that will put Europe's biodiversity on the path to recovery by 2030, for the benefit of people, the climate and the planet. It will also prepare the EU to take a leading role in the upcoming international negotiations on a new global framework to halt biodiversity loss. With the Green Deal's 'do no significant harm' vision, all EU policies will become more biodiversity-friendly, focusing more on the sustainable use of ecosystems, supporting the recovery in a post-pandemic world6. This policy vision is fully supported in the strategic plan of Horizon Europe for 2021-2024 in its first key strategic orientation 'Protecting and restoring ecosystems and biodiversity and managing sustainably natural resources on land and at sea, and achieving climate neutrality and adaptation'. Consequently, Destination 'Biodiversity and ecosystem services' intends to achieve the following expected impact from Cluster 6 **'Biodiversity is back on a path to recovery, and ecosystems and their services are preserved and sustainably restored on land, inland water and at sea through improved knowledge and innovation'**. All actions funded under this destination must therefore help to deliver this main impact.

Research and innovation is key to delivering results that will have an important impact on biodiversity, food, health, water and climate, which are all interconnected, and to achieving the goal of healthy and resilient ecosystems by 2030. It will also enable transformational change engaging European society and economy and their global impacts, making decisions more biodiversity-friendly. R&I will support policy targets, develop nature-based solutions7 and holistic approaches to address the main causes of biodiversity loss, particularly in connection to production systems, bringing all sectors together to be integrated in ecosystem-based management. Investments in R&I will help to protect and restore the integrity of terrestrial, aquatic and marine ecosystems, currently under multiple pressures, and protect and restore their capacity to deliver a wide range of essential services. Under Horizon Europe, a **long-term strategic research agenda for biodiversity** will also be developed.

The sixth mass extinction is taking place: one million species are at risk of extinction, and the degradation of ecosystems severely affects the fabric of life that enables the survival of humankind8. None of the globally agreed targets of the 2011-2020 strategic plan for

[3] Work Programme published by the European Commission on 15 June 2021

biodiversity has been fully achieved9, with the biodiversity crisis even deepening. Our knowledge on biodiversity status, pressures, impacts and responses needs to be improved, requiring even basic taxonomic work in certain ecosystems. **Understanding biodiversity decline** and addressing its main drivers through data-driven science, integrated multidisciplinary knowledge, new tools, models and scenarios, will support Europe's policy needs and boost global biodiversity science. Solutions for preventing and addressing the individual and cumulative effect of direct drivers of biodiversity loss (land use change, overexploitation, climate change, invasive species, pollution) need to be further developed and made available to policy makers and practitioners, such as through the new EC Knowledge Centre for Biodiversity10. For more impact on society and economic sectors, citizen science and crowdsourcing also require big data analysis, artificial intelligence, social sciences, communications and policy tools.

Valuing and restoring biodiversity and ecosystem services is necessary to develop tools to guide decisions, inform and implement policies on the environment, water, health, climate, disaster risk reduction, agriculture, forests and other land use types, protected areas management, the sustainable bioeconomy, the blue economy, maritime and cross-sectoral spatial planning, and responsible business practices. The continued degradation of the ecosystems and their services affects biodiversity and climate change11, and increases the risk of severe ecological disasters and pandemics. The European Green Deal and its biodiversity strategy call for urgent action to restore damaged aquatic and terrestrial ecosystems in order to increase biodiversity and deliver a wide range of ecosystem services.

The contribution of ecosystems to human wellbeing and the economy is not properly accounted for in market transactions, or in planning and investment decisions: the social and economic co-benefits of healthy ecosystems are often disregarded. Natural capital accounts need to be developed and mainstreamed. Investments in R&I will also lay the ground for scaling up and speeding up the implementation of technological, societal and nature-based solutions (NBS). NBS support vital ecosystem services, biodiversity and biomass provision, as well as access to drinking water, clean soil, improved livelihoods, healthy diets and food safety and security from sustainable food systems. NBS deployment will also create green jobs and build resilience to climate change and natural disasters. Citizens, authorities, businesses, social partners and the research community must be engaged at local, regional, national and European levels.

Managing biodiversity in primary production: Biodiversity is the basis for sustainable and resilient agriculture, fisheries, aquaculture and forestry, as also recognised in the farm to fork and biodiversity strategies under the Green Deal. With diverse genetic resources, it is possible to use in primary production plants and animals that are adapted to different

environments, ecosystems and meet diverse needs. Furthermore, the interplay between species below and above ground delivers important ecosystem services, such as pollination, soil fertility, pest and risk control. Despite these recognised benefits, current production systems tend to be specialised and rely on a limited number of crops, breeds and forest tree species whose genetic basis is narrow. Reversing this trend and increasing their resilience is critical and of global concern in particular in the current context of accelerated climate change and a growing population whose production and consumption footprint is increasing.

Enabling transformative change12 in biodiversity: Science (IPBES and IPCC) and Policy (the global post-2020 biodiversity framework and the EU biodiversity strategy) clearly underline that biodiversity loss can only be successfully addressed if transformative changes are initiated, accelerated, and up-scaled. There is however hardly any knowledge on potentials and challenges arising from transitions focused on biodiversity. System-level change of this kind starts with social innovation in the form of, for example, regulations, incentives, local and participatory processes, and through the introduction of new technologies, new production processes, or new consumer products, which change how socio-technical and socio-ecological systems operate and impact their environment. Such transformative change must decrease the impacts of indirect drivers of biodiversity loss, which are in turn, underpinned by societal values and behaviours. Indirect drivers of biodiversity loss are understood to mean here: production and consumption patterns, human population dynamics and trends (including their footprints), trade, technological innovations, and local to global governance (including financing). Research and innovation can enable these transformative changes to happen and initiate processes, behaviour changes and actions which are transforming the way we impact biodiversity. Socio-economic and multidisciplinary research, including on the role of education, will develop knowledge and tools to understand the role of transformative change for biodiversity policy making, address the indirect drivers for biodiversity loss, and accelerate transformative changes in our society that are relevant to biodiversity.

Interconnecting biodiversity research and supporting policies refers to the establishment of the European Partnership 'Rescuing biodiversity to safeguard life on Earth' and to the support to other science-policy interfaces. The European partnership on biodiversity13 will connect national, local and European research, innovation and environmental programmes, combining resources in support of one goal, i.e. that by 2030 biodiversity in Europe is back on the path to recovery. It will co-develop multidisciplinary research and innovation programmes with stakeholders, set up a European network of coordinated observatories for biodiversity monitoring, and implement a broad range of

activities to increase the relevance, impact and visibility of EU research and innovation in tackling the biodiversity crisis in line with the EU biodiversity strategy for 2030.

Science-policy interfaces on biodiversity and nature-based solutions have made good progress in recent years14, and must be stepped up to achieve targeted impacts on biodiversity-relevant policies, that can in turn be used as structured policy input into the research cycle. These interfaces are also key to guiding biodiversity governance, and to implement the EU Green Deal and international conventions15. In line with the Commission priority 'A stronger Europe in the world', the EU must take and demonstrate leadership in this field, notably by increasing its support to IPBES16 -to bring it up to the same level as the IPCC-, and to the Convention on Biological Diversity. Besides economic support, this also includes efforts to create synergies and cooperation between IPBES, regional Multilateral Environmental Agreements and other relevant research communities to ensure a full coverage of all relevant aspects of biodiversity and ecosystem services in order to underpin the full scope of the post 2020 global biodiversity framework.

All topics will directly contribute to the EU biodiversity strategy for 2030 and to the Sustainable Development Goals (SDGs) 13, 14, 15, 17.

Several missions will also help to achieve biodiversity-related impacts, notably in the areas of 'Adaptation to climate change including societal transformation', 'Climate-neutral and smart cities', 'Ocean, seas and waters' and 'Soil health and food'.

Expected impact

Proposals for topics under this destination should set out a credible pathway contributing to Biodiversity and Ecosystem Services, and more specifically to one or more of the following impacts:

- **Biodiversity decline, its main direct drivers and their interrelations are better understood and addressed** through the production, integration and use of open data, knowledge, education and training, innovative technologies, solutions and control measures, in collaboration with European and international initiatives.
- **Biodiversity and natural capital are integrated into public and business decision-making at all levels for the protection and restoration of ecosystems and their services**; science base is provided for planning and expanding protected areas, and sustainably managing ecosystems.
- **Europe builds competitive sustainability and tackles climate change and natural disasters through the deployment of nature-based solutions**, including

ecosystem-based disaster risk-reduction approaches fully reaping their economic, social and environmental benefits for a green recovery across all European regions.

- **The interrelations between biodiversity, health, food, soil, water, air and climate are better known** and communicated to citizens and policy-makers; in particular, risks associated with microbiomes and biodiversity-friendly prevention/mitigation measures, and opportunities for biodiversity recovery are identified.

- **Practices in agriculture and forestry support biodiversity and the provision of other ecosystems services** based on a) a better understanding of functional biodiversity (above and below ground), b) effective knowledge and innovation systems and c) ready-to use solutions for land managers, adapted to specific conditions.

- **Access to a wider range of crops and breeds with a broadened genetic base is improved in line with global biodiversity commitments** by gaining greater insight into the characteristics of genetic resources and by enhancing capacities for their preservation and use in breeding and in primary production (farming, forestry, fisheries, aquaculture). More (bio)diverse, resilient production systems will have positive knock-on effects on value chains, consumption, healthy diets and the wider, non-managed biodiversity.

- **Approaches for enabling transformative changes in society** for biodiversity and ecosystems recovery are identified, tested and implemented in policy, governance, law business and society; all indirect drivers of biodiversity loss are addressed and 'do not harm' biodiversity policies become a mainstream part of all sectors.

- **Biodiversity research is interconnected** across Europe, supporting and enhancing the ambition of national, EU and international environmental policies and conventions.

When considering the impact of the proposals, their compliance with the 'do no significant harm' principle17 has to be assessed. Also it has to be ensured that the research and innovation activities do not cause a significant harm to any of the six environmental objectives of the EU Taxonomy Regulation.

The portfolio of actions under this destination will have impacts in the following areas: "Enhancing ecosystems and biodiversity on land and in waters"; "Climate change mitigation and adaptation"; "Clean and healthy air, water and soil"; "Sustainable food systems from farm to fork on land and sea"; and "A resilient EU prepared for emerging threats".

Call – Biodiversity and Ecosystem Services 2021

Enabling transformative change on biodiversity

Topic ID and title	HORIZON-CL6-2021-BIODIV-01-18: Understanding the impacts of and the opportunities offered by digital transformation, new emerging technologies and social innovation with respect to biodiversity				
Budget	EUR 5 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 2 to 3 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	F&F, WW, P&P				
Keywords	Digital technologies, Artificial Intelligence (AI), biodiversity loss, ecosystem services, policy making, governance, Copernicus, GEO, GEOSS				
FTP comments					
FTP SIRA 2030 Challenges addressed	1A			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

Expected Outcome

In line with the EU biodiversity strategy, successful proposals will develop knowledge and tools to understand the role of transformative change for biodiversity, tackle indirect drivers of biodiversity loss, and initiate, accelerate and upscale biodiversity-relevant transformative change in our society.

Digital technologies are transforming all sectors of society, from food production to mobility, energy, climate mitigation and adaptation measures, construction, infrastructure, technology use, human behaviour and societal organisation, with different impacts on and perceptions of biodiversity, due to the speed, scale and level of connectivity of these transformations. Projects should help identify a safe operating space, in which digitalisation and new emerging technologies generate no unsustainable rebound effects, but instead can be a vehicle for accelerating and amplifying the transition to a safe and just world for humankind whilst protecting, restoring and sustainably using biodiversity and ecosystem services.

Project should address all following outcomes:

- A better understanding, today and for the future, of the impacts on, risks and opportunities for biodiversity of digital transformation (for example smart technologies, artificial intelligence, automation, miniaturised sensors, citizen science applications, crowdsourcing), new materials (e.g. for biomimicry), and new and emerging technologies.

- Identification and an assessment of how system-level change affecting biodiversity through social innovation happens. This should cover bringing in new technologies, new production processes, consumer products, regulations, incentives, or participatory processes, and changes how socio-technical and socio-ecological systems operate.

- Making proposals for safeguards to build public understanding of the range of diverse values held by members of the public (i.e. indigenous communities, youth, women, vulnerable groups in society, socially or economically marginalised groups), to promote democracy and a socially just transition taking action on biodiversity. Proposals should promote incorporating these safeguards in transformative processes linked to the digital sector and technology, which can have positive or negative impacts on biodiversity and on the wide range of services ecosystems can provide.

- Demonstrating the potential of social innovation to tackle biodiversity loss, as well as using biodiversity and the ecosystem services it provides, with nature-based solutions as case studies. Demonstrating how nature-based solutions, enabled by social innovation, tackle poverty, low resilience and social inequality to achieve a just transition.

- Testing active intervention by R&I policy and sector policies (niche creation, reformulation of governance, 'exnovation'), also by empowering and endowing communities.

- Approaches, tools and knowledge influence policies provided at the right level on transformative change for biodiversity. The key elements for this change are to be delivered by the portfolio of cooperating projects (of which these projects form part).

Outcomes should be formulated in such a way that enables their potential users (policy makers, institutions, businesses, engineers, civil society) to understand and concretely apply them, including for monitoring, accounting and reporting purposes. The outcomes should be translated into options to ratchet up the targets and enabling mechanisms of the EU biodiversity strategy for 2030, the global post-2020 biodiversity framework, and to feed input into the processes on the Paris Agreement, the Sustainable Development Goals and IPBES. With the focus on the impacts and opportunities of digital transformation, new emerging technologies and social innovation on biodiversity for the EU and associated countries, projects are strongly encouraged to engage in international cooperation, in particular with African countries, Brazil, Latin American and Caribbean countries or the Mediterranean region, in order to understand differences between the EU/AC and other world regions.

Scope

- Proposals should generate, collect and distribute knowledge on how to tackle the indirect drivers of biodiversity loss linked to technological and social innovation, which includes digitalisation. They should also assess the impacts on biodiversity of the digital divide between urban, peri-urban and rural areas. Proposals should explain how changes in our societies are fostered by technological and social innovation impacting biodiversity – for example by bringing in new and emerging technologies, new production processes, consumer products, regulations, incentives, or participatory processes, which change how socio-technical and socio-ecological systems operate.

- Proposals are expected to contribute to informing stakeholders and users on the social and technological impacts of new and emerging technologies that are not covered by existing procedures for biodiversity-related risk assessments79. This includes the wider positive and negative impacts on societal values, behaviour, institutional, financial and business frameworks, which in turn are having an impact on biodiversity and the capacity of ecosystems to provide a wide range of services.

- Proposals should assess which tools further mainstream biodiversity into policy making, and governance (including financing, the promotion of innovation, and bringing in new and emerging technologies) to achieve transformative action that benefits biodiversity, to avoid, mitigate or manage conflicts linked to these transformational changes80. In doing this, proposals should engage with civil society, policy makers, finance and business leaders, to create a toolbox for transformative change via action on biodiversity.

- Proposals should build their analysis on the synergies between multiple Sustainable Development Goals to deliver both direct and indirect biodiversity benefits, staying within planetary boundaries, and on the role of biodiversity in reaching the set of Sustainable Development Goals. Proposals should factor in impacts and opportunities of digital transformation, new emerging technologies and social innovation on biodiversity. This explicitly includes the interdependence of biodiversity loss and climate change, and the impacts on biodiversity of digital, technological or social approaches on action to mitigate and adapt to climate change – and vice versa.

- Proposals should develop pathways for digital developments to achieve a successful twin digital and biodiversity transition. They should develop methodologies to assess their impacts (including the impacts from energy/electricity infrastructure, or on democracy and on trust in science) on environmental, social and economic systems.

Such assessments should focus on the direct and indirect effects of digital developments on biodiversity, intertwined with climate change and health.

- Proposals should provide case studies and a collection of good and failed examples, including current relevant business models, the role of citizen science, and scenarios that could provide useful impact to these transformations and inform and inspire transformative change through learning, co-creation and dialogue.
- Proposals should include specific tasks and allocate sufficient resources to develop joint deliverables (e.g. activities, workshops, and joint communication and dissemination) with all projects on transformative change related to biodiversity funded under this destination. They should use existing platforms and information sharing mechanisms relevant to transformational change and to biodiversity knowledge81. Furthermore, projects are expected to cooperate with the Biodiversity Partnership and the Science Service. Proposals should show how their results and outcomes can provide timely information to major science-policy bodies such as the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC), and to the Convention on Biological Diversity. They are expected to cooperate with projects 'HORIZON-CL6-2021-BIODIV-01-20: Support to processes triggered by IPBES and IPCC' and 'HORIZON-CL6-2021-BIODIV-2022-01-10: Cooperation with the Convention on Biological Diversity'.
- Where relevant, projects are expected to create links to and use information, data and impact-related knowledge from the European Earth observation programme Copernicus, the Group on Earth Observations (GEO) and the Global Earth Observation System of Systems (GEOSS).

Interconnecting biodiversity and supporting policies

Topic ID and title	HORIZON-CL6-2021-BIODIV-01-21: Impact and dependence of business on biodiversity				
Budget	EUR 5 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 2 to 3 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	F&F, WW, P&P				
Keywords	Ecosystem services, corporate decision making, business resilience, investment risks, interdisciplinary				
FTP comments					
FTP SIRA 2030 Challenges addressed	1A - 2E			**FTP relevance**	Low/Medium
				Starting TRL	/
				End TRL	/

Expected Outcome

In line with the EU biodiversity strategy for 203095, the topic aims to support the development of policies, business decisions and knowledge generation, to tackle the indirect drivers of biodiversity loss, and accelerate biodiversity-relevant transformative changes in businesses and our society.

Successful proposals will help integrate biodiversity into business decisions to improve:

- public health and well-being and to tackle inequalities, create new jobs and sustainable growth in rural, post-industrial and coastal areas; strengthen resilience against environmental and climate stressors; minimise the risks of future diseases linked to business activities, with disastrous health, economic and social impacts, and
- corporate decision making and business resilience and to minimise investment risk and thereby play a key role in the sustainable transition of the economy.

Projects should produce all following outcomes:

- A better understanding and awareness of how businesses depend, and impact upon, biodiversity and ecosystem services, based on past and ongoing knowledge, also from practical business experience (by private companies), to feed into business decision making.
- Making available knowledge (e.g. meta-studies, publications) for the production of the IPBES methodological assessment on business and biodiversity, which is planned to be adopted in 2024-25, following a fast-track approach. Putting in place capacity building, policy support, and science brokerage of the projects, including after the

release dates of the IPBES assessment, through effective and impactful dissemination.

Making accessible scientific evidence that is directly relevant to multiple Sustainable Development Goals, in particular closely related to Goals 9 (build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), 12 (ensure sustainable consumption and production patterns, i.e., issues of production and efficient use of natural resources), 13 (climate change), 14 (life below water) and 15 (life on land).

Scope

Key economic sectors depend on and have a direct and indirect, positive or negative impact on biodiversity. Biodiversity is directly at the centre of many economic activities, and a healthy biodiverse planet is a precondition for humankind to exist – and thus for businesses to grow and for the economy to recover following a crisis such as the COVID-19 pandemic.

Keeping nature healthy is critical for the economy, both directly and indirectly. The World Economic Forum ranks biodiversity loss and ecosystem collapse as one of the top five threats humankind will face in the next ten years. Businesses rely on biodiversity as inputs into their production processes, with over half of global GDP – some €40 trillion – dependent on nature and the services it provides.

Conversely, if we continue doing business as usual, and contribute to destroying ecosystems, the continued degradation of our natural capital will considerably limit business opportunities and socio-economic development potential. Internalising biodiversity into business decisions can enhance the health and well-being of all people and tackle inequalities, create new jobs and sustainable growth in rural, post-industrial and coastal areas; strengthen resilience against environmental and climate stressors; and minimise the risks of future outbreaks of infectious diseases with disastrous health, economic and social impacts. From the perspective of the private sector companies, integrating natural capital and biodiversity impacts and dependencies will enhance corporate decision making and business resilience as well as minimise investment risks. It will better inform, transform and improve their companies' sustainable decision-making processes, including by removing key blind spots in company risk assessments.

This means putting together a highly interdisciplinary team of experts, including biodiversity and corporate practitioners. It needs to cover biophysical and socio-economic aspects related to multiple sectors that have different impacts and ways of managing and accounting. Key expertise is needed in accounting, ecology, business management and organisation, social, political and environmental economics. This topic does not cover developing natural capital accounts or measuring biodiversity footprints.

The proposals should cover all of the following points:

- identifying criteria and indicators for measuring dependence, impact and contribution to the recovery of biodiversity and ecosystem services;
- developing methods to reduce adverse impacts and related material and reputational risks, and to develop the business case for long-term sustainability, for business sectors in addition to forestry, agriculture and fisheries, tourism, energy and mining, infrastructure and manufacturing and processing, that are directly dependent upon ecosystem services;
- developing a tool box to measure, assess and monitor the dependence and impact of the business sector on biodiversity, improved risk management linked to biodiversity, and the contribution of business to biodiversity recovery96;
- assessing the broader impact of businesses on biodiversity, the cumulative impact and the indirect impact from supply chains, trade or substitution effects (such as tele-coupling);
- collating targets and regulations (at any level within the EU and in associated countries) that stimulate innovation generating a positive impact on biodiversity and on the decoupling of environmental pressures from increased output;
- promoting (1) business cases that contribute to the conservation, restoration and sustainable use of biodiversity and the wide range of ecosystem services and (2) public accountability, informing regulatory agencies and guiding financial investments and influencing producer, retailer and consumer behaviour. Analysing the added value of creating a Horizon Europe prize97 for innovative businesses that improve biodiversity and its wide range of ecosystem services, focused on nature-based solutions98. Delivering timely input to IPBES assessment on business, and the processes on IPBES objectives for building capacity, strengthening the knowledge basis, supporting policy, and communicating and engaging, on impact and dependence of business on biodiversity, and the relevant IPBES task forces.

Proposals should also show how their results could provide timely information on project outcomes to the Intergovernmental Panel on Climate Change (IPCC), and to the Convention on Biological Diversity. Projects are expected to cooperate with projects HORIZON-CL6-2021-BIODIV-01-20: Support to processes triggered by IPBES and IPCC, HORIZON-CL6-2022-BIODIV-01-10: Cooperation with the Convention on Biological Diversity and HORIZON-CL6-2022-BIODIV-01-04: Natural capital accounting: Measuring the biodiversity footprint of products and organizations.

Proposals should make available the relevant evidence, data and information via the Oppla portal, and prepare to feed in the uptake of its results according to an agreed format to the EC Knowledge Centre for Biodiversity. Collaboration with the Knowledge Centre should also include its stakeholders forum.

The project should set out a clear plan on how it will collaborate with other projects selected under this and any other relevant topics, such as HORIZON-CL6-2021-BIODIV-01-16: Biodiversity, water, food, energy, transport, climate and health nexus in the context of transformative change, and with the European partnership on biodiversity HORIZON-CL6-2021-BIODIV-02-0199, by participating in joint activities such as workshops or communication and dissemination activities. The project should also set out a clear plan on how it will collaborate with key business-related networks that promote the integration of biodiversity into corporate decision making. Proposals should include specific tasks and allocate sufficient resources for these coordination measures.

This topic should involve the contributions from the social science and humanities disciplines.

Call – Biodiversity and Ecosystem Services 2022

Valuing and restoring biodiversity and ecosystem services

Topic ID and title	HORIZON-CL6-2022-BIODIV-01-04: Natural capital accounting: Measuring the biodiversity footprint of products and organizations				
Budget	EUR 10 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 10 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	Biodiversity, corporate natural capital accounting, Product Environmental Footprint (PEF)				
FTP comments					
FTP SIRA 2030 Challenges addressed	1E - 3			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	/

Expected Outcome

In keeping with the EU biodiversity strategy for 2030 the successful proposal is expected to contribute to measuring and integrating the value of nature into public and business decision making at all levels for the protection and restoration of ecosystems and their services.

Successful proposals will contribute to all the following expected outcomes:

- Change the way in which EU and associated countries organizations and companies allocate capital or influence their activities to promote a sustainable management by mainstreaming the use of corporate natural capital accounting.
- Integrate biodiversity and ecosystem considerations into business decision-making at different levels by measuring the biodiversity footprint of products and organisations through improving, developing and implementing standardised methods, criteria and standards that focus on essential features of biodiversity, ecosystems services, values, and sustainable use.
- Improve corporate biodiversity disclosure through innovative approaches to foster principles of biodiversity data transparency to accurately report on biodiversity, ecosystems and services.
- Demonstrate innovative solutions for valuing business impacts and dependencies in biodiversity and ecosystem and how this ends up in risks and opportunities for businesses private decision-making.

- Explore solutions to decrease the biodiversity footprint of retailers in global value chains.

Scope

The EU biodiversity strategy for 2030 recognises that biodiversity considerations need to be better integrated into public and business decision-making at all levels. This should include measuring the environmental footprint of products and organisations on the environment, through life-cycle approaches complemented and eventually integrated by natural capital accounting. In this context, the Commission will support the establishment of an international natural capital accounting initiative.

Natural capital accounting has potential in providing a meaningful basis for business performance reporting by explicitly mapping out impacts and/or dependencies on natural resources and placing a monetary value on them. Specific examples include business accounting and reporting and the disclosure of non-financial reporting and accounting directives.

The successful proposal should develop, take up or demonstrate in real settings standardised natural capital accounting practices to support companies to measure, value and synthetise biodiversity and ecosystem risks assessment, notably in a way that is suitable for routine consideration in business and economy decision-making (including at executive level). It should also mainstream environmental footprints methods for instance through quantifying the environmental impacts of products, or supply and value chains, business models or organisations based the Commission Organisation Environmental Footprint (OEF) and the Product Environmental Footprint (PEF).

The successful proposal should contribute to the alignment of natural capital accounting between the public and private sectors and to explore how the links to link the collection and use of statistics and data for natural capital accounting. It should also address the obstacles businesses are facing, in particular on data collection and improving the access and utility of European environmental data sets at different levels (i.e.: national statistical offices, environmental agencies, corporate reports) allowing better corporate and national data integration for economic and financial decision making.

The successful proposal should work on methodologies for companies to set science-based biodiversity targets. It should also address the specific decision-making needs of corporates and financial service provider to allow a specific and meaningful linkage with the macro-economic perspective and the ecological concept of planetary boundaries at the scale of decision to be taken at corporate level enabling to assess and understand to corporate safe operating space.

The successful proposal should develop and test concrete natural capital accounting and reporting frameworks for business performance with respect to biodiversity and ecosystem services reporting. This should include explicit mapping of the impacts and/or dependencies on natural resources and placing a monetary value on them. Specific examples should include business accounting, reporting, and the disclosure of non-financial reporting.

The successful proposal should explore to which extent the System of Environmental-Economic Accounting / Experimental Ecosystem Accounting (SEEA EEA) framework in its current form is useful for natural capital assessment and natural capital accounting by businesses. This should be done both in terms of methodological approach and data collection o the opportunities for adapting the SEEA EEA framework to make it more tailored to the business needs or the extent to which national statistical offices can benefit from data collection by businesses.

The successful proposal should develop and test concrete natural capital accounting basis for business performance on biodiversity and ecosystem services reporting by explicitly mapping out impacts and/or dependencies on natural resources and placing a monetary value on them. Specific examples should include business accounting, reporting, and the disclosure of non-financial reporting.

The successful proposal should support the European contribution to a globally consistent approach to account for ecosystems and their value. The proposal should ensure that the EU continues to play a lead role in international environmental affairs through its support for effective measures, international standards and accounting relating to natural capital.

The successful proposal should improve the access and utility of European environmental data sets at different levels (i.e: national statistical offices, environmental agencies, corporate reports) allowing better corporate and national data integration for economic and financial decision making.

The successful proposal should support developing and testing natural capital and biodiversity based business models. These are expected to invest in nature for the benefit of biodiversity, ecosystems functioning and ecosystem services and address the challenge to turn the value of ecosystem into a revenue stream. The successful proposal should help making natural capital and biodiversity based business models bankable, thereby enabling private investments in nature conservation. In other words, ‘how to facilitate making money with nature by enhancing ecosystem conditions but not by exploiting it to the detriment of nature’.

The successful proposal should therefore take stock and establish links with the work undertaken by ongoing initiatives, European and national platforms on business and

biodiversity, the Natural Capital Protocol, Value balancing alliance, the Knowledge Innovation Project KIP INCA and other Horizon 2020 related projects117.

The successful proposal should support the practical implementation of corporate reporting obligations such as under the EU Non-Financial Reporting Directive (2014/95/EU)118 or of the EU Taxonomy on Sustainable Finance.

Applicants should create synergies with relevant projects under this call ('HORIZON-CL6-2021-BIODIV-01-07: Ecosystems and their services for an evidence-based policy and decision-making'; 'HORIZON-CL6-2021-BIODIV-01-17: Policy mixes, governance (including financing) and decision-making tools for transformative action for biodiversity' the EU Biodiversity Partnership and the Science Service. To this end, proposals should include specific tasks and appropriate resources for coordination measures, and, where possible, envisage joint activities and joint deliverables.

The proposal should set practical policy recommendations for the EU biodiversity strategy for 2030 targets and commitments. Proposals should contribute to strategic dialogue with the EC Knowledge Centre for Biodiversity forum and ensure that all evidence, results, data and information will be accessible and interoperable with the KCBD119.

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 should include the effective contribution of social sciences and humanities disciplines.

Enabling transformative change on biodiversity

Topic ID and title	HORIZON-CL6-2022-BIODIV-01-08: Assessing the nexus of extraction, production, consumption, trade and behaviour patterns and of climate change action on biodiversity in the context of transformative change				
Budget	EUR 12 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 3 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	F&F, WW, P&P				
Keywords	Biodiversity loss, human impacts, primary production, ecosystem services, bioeconomy, multi-actor approach, nature-based solutions (NBS), environmental footprint, GIS-mapping, Bid data, Copernicus, GEO, GEOSS				
FTP comments					
FTP SIRA 2030 Challenges addressed	1A			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	/

Expected Outcome

In line with the EU biodiversity strategy, a successful proposal must develop knowledge and tools to understand the role of transformative change for biodiversity policy making, address the indirect drivers of biodiversity loss, and initiate, accelerate and upscale biodiversity-relevant transformative changes in our society.

Projects must address all of the following outcomes:

- Economically, socially, ethically and institutionally viable and sustainable pathways are designed to minimise biodiversity loss or to enhance biodiversity. These pathways should consider mutually influencing extraction, production, consumption, trade patterns in the medium- and long-term (beyond 2030).
- Improve understanding of the human dimensions impacting biodiversity i.e. ethics, social context, institutions, organisation, behaviour will provide policy makers, industrial stakeholders and civil society the tools needed to reframe their actions, by highlighting the synergies of mainstreaming biodiversity with climate transitions, including on how to avoid or minimise trade-offs.
- Better understand social norms and behaviours, linked to socio-economic values (e.g. ethics, social context of individuals, consumers, institutions, organisations, industry) affecting biodiversity.
- Inform and motivate transformational change through learning, co-creation and dialogue based on case studies. The understanding of the biodiversity inter-

dependencies of the SDGs has improved; IPBES and IPCC are strengthened through European research and innovation. Provide a set of approaches, tools and knowledge influence policies at the appropriate level on transformative change for biodiversity – the key elements for this change are delivered by the portfolio of cooperating projects (of which these projects form part).

With focus on assessing the nexus of extraction, production (including processing), consumption, trade and behaviour patterns, including transformative changes for climate change on biodiversity for the EU and Associated Countries, international cooperation in particular with African countries, Brazil, Latin American and Caribbean countries or the Mediterranean region is strongly encouraged.

Scope

Proposals should address all the following points:

- Assess how extraction, production, processing, consumption, trade, behaviour patterns, especially linked to primary production (e.g. livestock with/or energy crops, etc. including through tele-coupling from consumption and all along supply chains), integrated food systems, and transformative changes towards climate neutrality, affect biodiversity and ecosystem services.
- Develop pathways together with key industries and key stakeholders to minimise loss of, and enhance biodiversity, whilst increasing the delivery of a wide range of ecosystem services. These industries cover food, feed, fibre, energy production and the wider food chain (related to bio-economy, renewable energies, infrastructure, technologies)122, and the deployment of climate mitigation and adaptation measures potentially harmful for biodiversity (e.g. concrete walls in coastal areas, replacement of biodiversity rich ecosystems for energy crops, etc.).
- Identify and address leverage points for transformational change in trade, triggering changes in established and new production and consumption patterns for new business models.
- Highlight the potential of (1) public procurement for delivering biodiversity benefits and (2) nature-based solutions for enabling and accelerating the relevant aspects of transformative change.
- Quantify investments into infrastructure and labour that could be shifted from impacting biodiversity negatively towards benefits for biodiversity, including the anticipation, mitigation and management of social, institutional and economic conflicts this may trigger (or decrease), to achieve a just transition process.

- Understand and engage communities and other social actors, including through citizens science, and initiate behavioural changes leading to production and consumption patterns preventing further biodiversity loss.
- Cooperate with ongoing activities to include biodiversity into integrated assessment models123 and analyse the usability of existing and emerging concepts such as 'Planetary Boundaries', 'Doughnut Economy', 'Environmental Footprints'.
- Explain the relevance of transition pathways for biodiversity for competitive sustainability, towards a just transition in the full range of SDGs and climate neutrality.

Unsustainable production and consumption, including the role of trade for linking both, are pushing many of the direct drivers of biodiversity loss: land use change, overexploitation, climate change and pollution. Proposals should, based on a clear understanding of these relationships124 address how leverage points and levers can be identified and used for generating benefits for biodiversity, e.g. through revision of regulation, standards, funding practices or governance processes.

They should highlight how the primary production sectors (in particular in agriculture, forestry, fisheries, raw material extraction, and also the construction sector) and the related infrastructure and energy provision and use impacts biodiversity directly. They should show effects on the direction of economic development, which leads to lock-in effects, inequalities, lack of capacities of institutions at every level to shift towards sustainable use, the protection and restoration of biodiversity and ecosystem services. On patterns of consumption, proposals should show how their impacts such as uneven use and exploitation of resources, generation of waste and pollution, value setting, power setting in societies, institutions and financial streams could be addressed in business, institutional and consumer agendas to achieve positive outcomes for biodiversity.

Proposals should assess the cultural diversity that influences these compromises and people's engagement, and lead the way to further mainstream biodiversity in socio-economic and environmental agendas, from the transformative aspect of changing extraction, production and processing, consumption, trade and behaviour patterns, including on actions for addressing climate change on biodiversity. They should also analyse and test the use of nature-based solutions as tool in this regard. Optimal and cost-effective use of behavioural games, networks of sensors, GIS-mapping, big data and observational programmes such as the European Earth observation programme Copernicus, through the Group on Earth Observations (GEO) and the Global Earth Observation System of Systems

(GEOSS) as well as citizens' observatories, should be used as appropriate to enable the integration and visualisation of data.

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.

Proposals should build their analysis upon the links between multiple Sustainable Development Goals, to deliver direct and indirect biodiversity benefits, and of the role of biodiversity in reaching the set of Sustainable Development Goals, when related to extraction, production, consumption, trade and behaviour patterns.

Proposals should produce case studies and collect good and bad examples that could inform these transformations and inform and inspire transformative change through learning, co-creation and dialogue.

Proposals should include specific tasks and ensure sufficient resources to develop joint deliverables (e.g. activities, workshops, as well as joint communication and dissemination) with all projects on transformative change related to biodiversity. This concerns projects funded under this destination, or under calls included in Destination 'Fair, healthy and environmentally-friendly food systems from primary production to consumption' related to transformational change (Fair, healthy and environmentally-friendly food systems from primary production to consumption) that aim to deliver various co-benefits, including on the reduction of biodiversity loss. Projects should use existing platforms and information sharing mechanisms relevant for transformational change and on biodiversity knowledge125. Cooperation and possibly synergies with relevant topics in Cluster 5 should be explored and established as relevant. Furthermore, cooperation is expected with the European partnership on biodiversity and with the Science Service.

Proposals should show how their results might provide timely information for major science-policy bodies such as the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC), as well as the Convention on Biological Diversity on project outcomes. Cooperation is requested with projects under 'HORIZON-CL6-2021-BIODIV-01-20: Support to processes triggered by IPBES and IPCC' and 'HORIZON-CL6-2022-BIODIV-01-10: Cooperation with the Convention on Biological Diversity'.

This topic should involve the effective contribution of social science and humanities disciplines.

Destination 3: Circular economy and bioeconomy sectors

This destination and its topics target climate-neutral **circular and bioeconomy transitions**, covering safe **integrated circular solutions at territorial and sectoral levels**, for important material flows and product value chains, such as the textile, electronics, plastics and construction sectors, as well as **key bioeconomy sectors** such as **sustainable bio-based systems, sustainable forestry, small-scale rural bio-based solutions**, and **aquatic value chains**. With this approach, the destination supports the European Green Deal, and other European initiatives such as the Industrial Strategy, SME Strategy, Circular Economy Action Plan, Bioeconomy Strategy, Biodiversity Strategy, Farm to Fork Strategy, Textile Strategy, Plastics Strategy, the Action Plan on Critical Raw Materials, and the Forest Strategy.

More specifically, the focus on **circularity**197 aims at less waste and more value by extending the lifetime and retaining the value of products and materials. It supports a sharing, reusing, and material-efficient economy, in a safe way, and minimises the non-sustainable use of natural resources. The cascading use of materials and innovative upcycling of waste to new applications is encouraged. The safe and sustainable use of biomass and waste198 for the production of materials and products, including nutrients, can reduce Europe's dependence on non-renewable resources, cut GHG emissions, offer long-term circular carbon sinks and substitutes to fossil-based and carbon-intensive products, and reduce pressures on biodiversity and its wide range of ecosystem services. The potential of biological resources goes beyond biomass processing into renewable products. It includes the use of organisms and their parts in "green" (i.e. more environmentally friendly) bio-based industrial processes. Marine and land-based biotechnology can provide new sustainable and safe food and feed production methods, greener industrial products and processes, new health-related products, and can help characterise, monitor and sustain the health of marine and terrestrial ecosystems. The potential of marine resources and biotechnology will contribute to the coming "blue economy", accelerating the transition towards a circular and climate-neutral economy that is sustainable and inclusive. The concepts of the circular economy, bioeconomy and blue economy converge and altogether provide an opportunity to balance environmental, social and economic goals, with their sustainability ensured by the life cycle assessment approaches.

Acknowledging the multiple benefits of circularized material/substance and energy flows, such circularity however has to be achieved in a safe, non-hazardous way without (re-)connecting epidemiological pathways or introducing pathogen/toxin enrichment cycles when involving biogenic materials. Established circularized material/substance flows have to be complemented with accompanying research in their safety and non-hazardous to health, society, economy and nature. In addition, a **local and regional focus**199 is crucial for a

circular economy and bioeconomy that is sustainable, regenerative, inclusive and just. Innovative urban and regional solutions and value chains can create more and better quality jobs and help our economies rebound from the COVID-19 crisis.

A systemic and science-based circular transition with the help of research, innovation and investments will address all issues from material selection and product design via resource efficiency along the value chain to an optimised after-use system, incorporating reuse, repair and upgrade, refurbishment, remanufacturing, collection, sorting and new forms of recycling and upcycling also to improve the waste cycle management. It will tackle all barriers and mobilise all key stakeholders. The development of definitions, taxonomies, indicators and targets will inform and support policy and decision making. The use of advanced life cycle methods such as the European Commission Product Environmental Footprint (PEF), data and information will enable economic actors, including consumers, to make sustainable choices. The development and deployment of specific technological and non-technological circular solutions, including new business models, will cover intra- and inter-value chain collaboration between economic actors. The development of a working after-use system for plastic-based products, incorporating reuse, collection, sorting, and recycling technologies will provide insights into the transition towards a circular economy for key material flows including plastics. The Circular Cities and Regions Initiative (CCRI)200 under the European Circular Economy Action Plan will expand the circular economy concept beyond traditional resource recovery in waste and water sectors and support the implementation, demonstration and replication of systemic circular solutions for the transition towards a sustainable, regenerative, inclusive and just circular economy at local and regional scale. Water use will be tackled from a circularity perspective, aiming at pollution prevention, resource efficiency and business opportunities.

Bio-based innovation lays the foundations for the transition away from a fossil-based carbon-intensive economy by encompassing the sustainable sourcing, industrial201202 and small scale processing and conversion of biomass from land and sea into circular bio-based materials and products with reduced carbon and environmental footprint including lower impacts on biodiversity and long-term circular carbon sinks in sustainable products substituting carbon-intensive ones, with improved end-of-life including biodegradability in specific natural as well as controlled environments. It also capitalises on the potential of living resources, life sciences and industrial biotechnology for new discoveries, products, services and processes, both terrestrial and marine. Bio-based innovation can bring new and competitive economic activities and employment to regions and cities in the recovery from the COVID-19 crisis, revitalising urban, rural and coastal economies and strengthening the long-term circularity of the bioeconomy, including through small non-food bio-based

solutions. Furthermore, targeted and well-tailored investments can increase and diversify the income of primary producers and other rural actors (e.g. SMEs).

To enable the bio-based innovation, environmental objectives and climate neutrality will build on a robust understanding of environmental impacts and trade-offs of bio-based systems at the European and regional scale, including the comparisons to similar aspects on the fossil and carbon-intensive counterparts. Systemic impacts of bio-based systems on biodiversity and its wide range of ecosystem services as well as how we restore and use them, need to be assessed, and negative impacts avoided in line with the "do no harm" principle of the European Green Deal. Implementing sustainable and just bio-based value chain requires symbiosis across primary production and industrial ecosystems in regions, Member States and Associated Countries and improved environmental performance of products, processes, materials and services along value chains and life cycles.

The **multifunctional and sustainable management of European forests** as well as the environmentally sustainable use of wood and woody biomass as a raw material have a crucial role to play in the achievement of the EU's climate and energy policies, the transition to a circular and sustainable bioeconomy as well as the preservation of biodiversity and the provision of ecosystem services such as climate regulation, recreation, clean air, water resources and erosion control among many others. Furthermore, forestry and the forest-based sector offer important opportunities for wealth and job creation in rural, peripheral and urban areas. The condition of European forests is increasingly threatened by a growing number of social, economic and environmental and climatic pressures. The European Green Deal and the EU Biodiversity Strategy for 2030 recognise that the EU's forested area needs to improve, both in quality and quantity, for the EU to reach climate neutrality and a healthy environment. The multifunctionality and the sustainable forest management under rapid climate change will be enabled through a variety of approaches, including the use of intelligent digital solutions, enhanced cooperation in forestry and the forest-based sector as well as the establishment of an open-innovation ecosystem with relevant stakeholders.

Aquatic biological resources and blue biotechnology are crucial to delivering on the Green Deal's ambition of a 'blue economy', which alleviates the multiple demands on the EU's and the Associated Countries' land resources and tackles climate change.

The immense marine and freshwater biodiversity both faces and offers solutions to multiple challenges such as climate, biodiversity loss, pollution, food security, green products, and health but remains largely unexplored. Unprecedented advances in the biotechnology toolbox (e.g. -omics, bioinformatics, synthetic biology) have triggered an increased interest in the potential of aquatic bioresources. Further research and innovation will be key to unlocking the value of the marine and freshwater biological resources available in Europe,

including its outermost regions by learning from the functioning and processes of aquatic living organisms to provide a sustainable products and services to the society, whilst avoiding systemic impacts on biodiversity. Algae biomass is becoming increasingly important not only as food but also as a sustainable source of blue bioeconomy products such as pharmaceuticals, cosmetics, and speciality chemicals. Although only a small fraction of marine microbial diversity has been characterised to date, advances in genetic and sequencing technologies are opening new avenues for the understanding and harnessing marine microbiomes such as for the biodiscovery of new products and services for the environment and society.

Expected impacts

Proposals for topics under this destination should set out a credible pathway to developing circular economy and bioeconomy sectors, achieving sustainable and circular management and use of natural resources, as well as prevention and removal of pollution, unlocking the full potential and benefits of the circular economy and the bioeconomy, ensuring competitiveness and guaranteeing healthy soil, air, fresh and marine water for all, through better understanding of planetary boundaries and wide deployment and market uptake of innovative technologies and other solutions, notably in primary production (forestry) and bio-based systems.

Specifically, the topics will target one or several of the following impacts, for circular economy, bio-based sectors, forestry and aquatic value chains:

- **Regional, rural, local/urban and consumer-based transitions** towards a sustainable, regenerative, inclusive and just circular economy and bioeconomy across all regions of Europe based on **enhanced knowledge and understanding of science**, in particular regarding biotechnology-based value chains, for all actors, including policy makers, to design, implement and monitor policies and instruments for a circular and bio-based transitions.
- **European industrial sustainability, competitiveness and resource independence** by lowering the use of primary non-renewable raw materials and reducing greenhouse gas emissions and other negative environmental footprint (including on biodiversity), enabling climate-neutrality and higher resource efficiency (e.g. by circular design, improved waste management, cascading use of biomass) along and across value chains, developing innovative and sustainable value-chains in the bio-based sectors, substituting fossil-based ones, increasing circular practices in textiles, plastics, electronics and construction, developing recycling technologies and industrial symbiosis, increasing circular bio-based systems from sustainably sourced

biological resources replacing carbon-intensive and fossil-based systems, with inclusive engagement of all stakeholders;

- **Improved consumer and citizen benefits**, including in the rural settings by establishing circular and bio-based systems based on sustainability, inclusiveness, health and safety; reaching a significantly higher level of involvement of all actors (manufacturers, retailers, consumers, public administration, primary biomass producers etc.);
- **Multi-functionality and management of forests** in Europe based on the three pillars of sustainability (economic, environmental and social);
- **Enlarged potential of marine and freshwater biological resources and blue biotechnology** to deliver greener (climate-neutral circular) industrial products and processes, and to help characterise, monitor and sustain the health of aquatic ecosystems for a healthy planet and people.

When considering their impact, proposals also need to assess their compliance with the "Do No Significant Harm" principle203 according to which the research and innovation activities of the project should not be supporting or carrying out activities that make a significant harm to any of the six environmental objectives of the EU Taxonomy Regulation.

In addition to the impacts listed above, topics under this destination will address the following impact areas of the Horizon Europe Strategic Plan for 2021-2024: "Climate change mitigation and adaptation", "Enhancing ecosystems and biodiversity on land and in waters", "A resilient EU prepared for emerging threats"; "Inclusive growth and new job opportunities"; "Industrial leadership in key and emerging technologies that work for people".

Call – Circular economy and bioeconomy sectors 2021

Enabling a circular economy transition

Topic ID and title	HORIZON-CL6-2021-CircBio-01-03: Innovative solutions to over-packaging and single-use plastics, and related microplastic pollution				
Budget	EUR 18 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 5 to 7 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Reuse, recycling, upcycling, waste streams, smart labelling, sensor-based sorting, bio-based materials, food packaging, life cycle approach				
FTP comments					
FTP SIRA 2030 Challenges addressed	9A,B			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	6-8

Expected Outcome

A successful proposal will contribute to all impacts in this destination related to consumers and industry, in particular to European industrial sustainability, competitiveness and resource independence by lowering the environmental footprint, enabling climate-neutrality and higher resource efficiency, through increased circularity and a resulting reduction in GHG and air pollution emissions.

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

- Increased deployment and market uptake of innovative solutions, through better design, alternative materials, business models promoting reuse, deposit systems, smart labelling in support of and complying with the current relevant legal framework and, when scope would cover the food chain, the future EU framework for sustainability labelling, etc.
- Increased reuse, recyclability and upcycling of packaging and single-use plastics
- Significant reduction in over-packaging and single-use plastics in consumer goods, food packaging and humanitarian relief items
- Significant reduction in packaging waste and single-use plastic waste
- Significant reduction in management costs for the respective waste streams
- Significant reduction in the release of microplastics from packaging and single-use plastics into the environment

Scope

The amount of materials used for packaging is growing continuously and in 2017 packaging waste in Europe reached a record – 173 kg per inhabitant, the highest level ever. In order to ensure that all packaging on the EU market is reusable or recyclable in an economically viable way by 2030, the essential requirements for packaging relate to reducing (over)packaging and packaging waste, designing for re-usable and recyclable packaging, including alternative reusable products or systems, and reducing the complexity of packaging materials.

Plastics continue to be one of the key areas in the 2020 circular economy action plan (CEAP). This is due to their circularity potential, but also due to concerns about their environmental footprint and the use of primarily fossil-based feedstock for their production. One of the main sources of pollution is the amount of single-use plastics and plastics packaging that is wasted daily and that overburdens our waste and water management systems. A particular issue regarding plastics is the pollution from microplastics and disintegrating material, which reaches the soils and ocean and whose possible health impacts on animals and humans still need to be assessed in depth. Some of these microplastics are added intentionally to products such as cosmetics, while other pollution comes from the disintegration and migration of various types of plastics during their use and waste phases. Plastic waste is also an unintended consequence of humanitarian response – often funded by European taxpayer money – and leading to pollution in countries receiving aid but without the capacity to manage the waste.

In line with the EU strategy for plastics in a circular economy and the Single Use Plastics (SUP) Directive, and in line with the priorities on plastics and packaging in the CEAP, projects should combine at least three of the following elements: a reduction of (over)packaging and packaging waste, design for reuse and recyclability of packaging, a reduction of material complexity including the number of materials used (including diverse polymers), the restriction of intentionally added microplastics, increasing the uptake of alternatives decreasing the dependency on fossil fuels and the related pollution, and measures to prevent the release of microplastics at all relevant stages of the product life cycle.

Projects should demonstrate at large scale and validate innovative solutions that are quantitatively relevant and replicable under diverse economic, geographical and social conditions, and across sectors, including humanitarian response, through better design, alternative materials (including biobased and biodegradable), business models promoting reuse, recycling, upcycling, deposit systems, smart labelling, sensor-based sorting, etc. to tackle over-packaging and single-use plastics in consumer goods, food packaging and humanitarian relief items. Where the use of alternative materials is concerned, projects should address aspects to assure quality and safety of these new alternatives.

All solutions should be based on life-cycle approaches. Proposals should integrate life cycle assessment using the European Commission's Product Environmental Footprint (PEF) method and relevant costing methods. Projects should choose a systemic approach to value chains and end users, including consumers as key actors. All achieved outcomes should be demonstrated using quantitative indicators and targets wherever possible.

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.

Research on the above issues in the humanitarian context (relating to humanitarian relief items) is also eligible under 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.

Topic ID and title	HORIZON-CL6-2021-CircBio-01-04: Increasing the circularity in textiles, plastics and/or electronics value chains				
Budget	EUR 22 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 6 to 8 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	P&P				
Keywords	Digital solutions, recycling, upcycling, repair, reuse, biobased resources				
FTP comments					
FTP SIRA 2030 Challenges addressed	4B,D - 9A			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	6-8

Expected Outcome

successful proposal will contribute to all impacts in this destination related to consumers and industry, in particular to European industrial sustainability, competitiveness and resource independence by lowering the environmental footprint, enabling climate-neutrality and higher resource efficiency, through increased circularity and a resulting reduction in GHG and air pollution emissions.

Project results are expected to contribute to at least four of the following outcomes:

- Increased deployment and market uptake of new technological solutions to waste management and recycling, and the measurement of recycled content
- Enhanced diffusion and demonstrated benefits of advanced digital solutions in circular businesses
- Emergence of new value chains using upcycled, recycled and/or biobased resources
- Increased upcycling and recycling rates for the targeted material streams
- Increased uptake of recycled material and upcycling to new higher-value products
- Increased resource efficiency along and across value chains, causing a measurable reduction in GHG emissions
- Increased diffusion of new circular business practices, in particular in the uptake of repair, reuse and remanufacturing
- A significantly higher level of involvement of all actors (manufacturers, retailers, consumers, CSOs, public administration etc.) in circular practices

- Increased level of information and awareness of citizens regarding circular and climate-neutral products and services
- Strengthened competitiveness and job retention and creation potential of circular value chains under different economic and social conditions

Scope

The 2020 circular economy action plan (CEAP) highlights the four material streams textiles, plastics, electronics including ICT equipment, and construction as particularly important with regard to their circularity potential and their environmental footprint. The circularity deficits for these streams are mainly due to the: lack of trust in secondary raw materials; lack of control over supply chains; lacking focus on material efficiency and design for circularity; unsustainable product lifetimes; lack of repair services; price gap between primary and secondary material; lack of secondary material markets; insufficient collection and sorting systems; insufficient and unpredictable input quality for recycling; insufficient information about quality and quantity of materials, including knowledge about possible microplastics pollution and substances of concern, lack of communication along the lifecycle between manufacturers and recyclers; lack of involvement and empowerment of citizens that would allow environmentally informed purchases.

Projects should address the priorities set in the CEAP, which states that “electrical and electronic equipment continues to be one of the fastest growing waste streams in the EU, with current annual growth rates of 2%. It is estimated that less than 40% of electronic waste is recycled in the EU. Value is lost when fully or partially functional products are discarded because they are not reparable.” Textiles are “the fourth highest-pressure category for the use of primary raw materials and water, after food, housing and transport, and fifth for GHG emissions, as well as one of the highest sources of emissions of synthetic microfibers in the EU. It is estimated that less than 1% of all textiles worldwide are recycled into new textiles.” “In the light of the complexity of the textile value chain, to respond to these challenges the Commission will propose a comprehensive EU Strategy for Textiles.” It will be necessary to boost “sorting, re-use and recycling of textiles, including through innovation”, while “tackling the presence of hazardous substances”. Beside the continuous implementation of the EU plastics strategy, the CEAP has a strong focus on microplastics, but also calls for mandatory recycled content and the controlled use of bio-based, biodegradable plastics and alternative materials. In view of the feasibility problems of plastic recycling, this will require the deployment of technologies that are still in their infancy, such as the various forms of chemical and enzymatic recycling.

Projects should deal with one of the three priority material streams (plastics, textiles, electronics), taking however into account the complexity of some materials currently in use (such as composites) and that the three streams are related and to some extent overlapping (plastics-textiles; plastics-electronics), and that specific solutions might require an integrated approach.

Projects should demonstrate and deploy at large scale innovative solutions and designs for increased quality, non-toxicity and durability of secondary materials and increased share of secondary materials in new products. Projects should demonstrate increased recovery, recycling and upcycling rates and a higher uptake of secondary materials for high value applications. Projects should also demonstrate circular business practices, in particular in the uptake of repair and reuse, remanufacture, product-service-systems, and in the full lifetime of products or services. To achieve this, targeted market size, economic feasibility, cost efficiency and social acceptance need to be addressed. To break down the barriers for this transition, it is important that proposals involve and address the different perspectives of all relevant actors, e.g. manufacturers, retailers, consumers and civil society organisations (CSOs). The projects should consider the use of digital solutions and demonstrate their benefits for increased circularity. Projects should also help produce harmonised and robust methods to assess the amount of recycled content in sectoral products, which is key for a future review of green claims through authorities and consumer organisations. Environmental, social and economic impacts should be assessed from a lifecycle perspective as product, organisation and consumption environmental footprints, using the respective methods developed by the European Commission (Product Environmental Footprint, PEF, should be used for the assessment of the environmental impacts) and through costing methods; relevant data should be fed into the European Platform on Life Cycle Assessment, following the specific Environmental Footprint data and format requirements. The functional performance of technologies and secondary materials can be assessed through the EU Environmental Technology Verification (ETV) scheme. Considering the microplastics and microfiber pollution and hazardous substances that are present in the targeted waste streams, their removal from the materials used for the products in concern as well as from the recovered material is crucial, in addition to applying less-polluting production and consumption procedures. Decontamination levels need to be properly addressed and accumulation prevented. All achieved outcomes should be demonstrated using quantitative indicators and targets wherever possible.

Projects should also develop training material to endow workers in this occupational group with the right skillset in order to deploy the new technologies developed. 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.

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.

Innovative sustainable bio-based systems and the bioeconomy

Topic ID and title	HORIZON-CL6-2021-CircBio-01-05: Novel, non-plant biomass feedstocks for industrial applications				
Budget	EUR 12 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 6 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Life-cycle assessment (LCA), upcycling, cascading use, biotechnology, plant-based biorefining, Bio-based Industries Joint Undertaking (BBIJU)				
FTP comments					
FTP SIRA 2030 Challenges addressed	2E - 3A - 6B			**FTP relevance**	Low
				Starting TRL	/
				End TRL	7

Expected Outcome

Successful proposals will contribute to the impacts of this destination and European policies it supports, in particular the European Green Deal, the circular economy action plan and the bioeconomy strategy. They should help to improve European industrial212 sustainability, competitiveness and resource independence by lowering environmental footprint (including on biodiversity), enabling climate-neutrality and higher resource efficiency (in particular upcycling and cascading use of biomass) along and across value chains, developing innovative bio-based products. They should engage all stakeholders, and improve their knowledge and understanding of science, in particular biotechnology-based value chains.

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

- More effective prospecting and greater use of biological diversity to generate verifiably more sustainable biomass feedstocks, including through improved harvesting, and processing, and commercially valuable climate-neutral circular bio-based, materials and products. This covers more robust verification of sustainability via life-cycle assessment approaches.

- Greater resource efficiency of production pathways, by applying upcycling and the cascading use of biomass residues or side-streams (e.g. as growing substrates), leading to lower land dependence for biomass213, and thus reducing any conflict with food/feed production.

- Higher capacity and engagement of SMEs, contributing to skilled job creation and economic benefits, and improving industrial competitiveness due to the expanded range of natural ingredients for the new applications in industrial sectors. Higher functional performance of the pursued value chains and products, and more

sustainable industrial practices and resource independence of the EU Member States and associated countries.

Better public understanding across the EU Member States and associated countries of biotechnology, and of the biodiversity conservation and enhancement objectives enshrined in the EU biodiversity strategy and respect to the principles of access and benefit sharing (UN Biodiversity Convention), via clear, inclusive and transparent communication strategies.

Scope

The innovative bioeconomy sectors need to diversify and to deliver technological and industrial solutions based on available and sustainably accessible biomass. In particular, current plant-based biorefining may need upgrading to leave more land available for biodiversity protection and food production, while allowing the substitution of fossil-based resources with bio-based ones. The scope therefore covers the production of key bio-based products such as food and feed ingredients, including proteins, lipids and fibres, antioxidants and other substances with biological activities, and key bio-based materials (e.g. bio-based plastics, composites, fibres) or chemicals214, in a resource-efficient approach215. This calls for identifying and optimising sources as microorganisms, insects, fungi or mixotrophic algae, which requires defining certain growing conditions in suitable systems such as biofermentors216, where they need to be efficiently processed, extracted and converted into industrial outputs of interest. Proposals should increase circularity, in particular for the use of biomass residues or side-streams used as feed material, and should deliver necessary upgrades to and upscaling of the strategies for the cultivation, production and extraction systems.

Where relevant, proposals should seek links with and capitalise on the results of past and ongoing research projects (especially under the Bio-based Industries Joint Undertaking or on microbiomes). Proposals should:

a. Develop and demonstrate techno-economic viability of the bio-based production platforms applying the resource efficiency principles (ensuring savings on water, energy, chemical inputs, biomass waste, side-streams or residues), getting more out of less by making use of autotrophic plants and heterotrophs, and applying the modern biotechnological principles. This covers the development of a bio-based microbial production platform for high-value biologically active substances, food/feed ingredients, or bio-based materials as well as efficient separation and extraction approaches for products of interest.

b. Identify and implement the best combination of appropriate technical solutions and practices for specific industrial value chains (justifying the choice, including on level of

innovation and business viability), as well as the barriers and drivers derived from e.g. governance and market aspects, while seeking the engagement and understanding of all actors.

c. Develop and transparently communicate the key parameters to monitor and measure the qualitative and quantitative impacts of these solutions and practices for different sourcing, optimization and production systems, the potential of replacing available traditional alternatives, if relevant, and trade-offs, including on biodiversity, and the associated improvement in socio-economic resilience of businesses, for the creation of jobs and industrial competitiveness.

d. Develop and test mechanisms involving all actors and specifically including bio-based industries active in knowledge co-creation, exchange, feedback and communication. Demonstrate them to all actors (e.g. agricultural operators, farmers, SMEs and civil society) and help them implement and understand solutions for new or improved bio-based products and processes and for addressing other environmental impacts e.g. lowered pressure on land and on biodiversity sourcing.

e. Consider contributing data and results to the European Commission's Knowledge Centre for Bioeconomy hosted by the JRC

In this topic it is not mandatory to integrate the gender dimension (sex and gender analysis) in research and innovation content.

Topic ID and title	HORIZON-CL6-2021-CircBio-01-06: Contained biomass solutions for sustainable and zero-Indirect Land Use Change (ILUC) production systems for high value applications				
Budget	EUR 10 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 5 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Upcycling, cascading use, biomass residues, biotechnology, biodiversity preservation, multi-species communities, bio-based industries				
FTP comments					
FTP SIRA 2030 Challenges addressed	10A,B			**FTP relevance**	Low
				Starting TRL	/
				End TRL	7

Expected Outcome:

Successful proposals will contribute to the impacts of this destination and the European policies it supports, in particular the European Green Deal, the circular economy action plan and the bioeconomy strategy, They should help improve European industrial217 sustainability, competitiveness and resource independence by developing innovative bio-based products. They should engage all stakeholders and improve their knowledge and understanding of science, in particular of biotechnology-based value chains, and increase benefits for consumers.

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

- Lower production costs, improved safety and access to final efficient, specific, high-yield and high-value, climate-neutral circular applications218
- Lower dependence on land-based production systems, minimising the risk of Indirect Land Use Change (ILUC)219, with specific technical solutions and strategies for innovative, high-output, multi-source high-value contained applications, based on a variety of biological organisms220 and their cultivation systems and technologies involved.
- Methodologically robust verification of sustainability of the production system via life-cycle assessment approaches. This covers the greater resource efficiency of production pathways, by applying the upcycling and cascading use of biomass residues or side-streams.
- More mature and advanced biotechnology solutions for the innovative culture, screening and processing of the selected organisms, as well as the related digital applications, thus contributing to European industrial competitiveness.

- Higher engagement of SMEs, for creating skilled jobs and bringing other socio-economic benefits for end users and/or patients, through expanding the range of natural ingredients for new applications in industrial sectors, enhancing the functional performance of the investigated value chains and products, and contributing to more sustainable industrial practices and resource independence of the EU Member States and associated countries.
- Better public understanding across EU Member States and associated countries of biotechnology, and of biodiversity conservation and enhancement objectives set out in the EU biodiversity strategy and respect for the principles of access and benefit sharing (UN Biodiversity Convention), via clear, inclusive and transparent communication strategies.

International cooperation is encouraged, to allow the exchange of best practice, while ensuring win-win scenarios and contributing to European competitiveness.

Scope:

The innovative bioeconomy sectors need to diversify and deliver technological and industrial solutions based on available and sustainably sourced biomass. In particular, this covers sustainable application in various industrial systems for high value products and uses, such as in the pharmaceutical, diagnostic and veterinary sectors221, especially in the context of biorefining and other (industrial) high-value uses222.

This calls for identifying, optimising, screening and monitoring of the growing conditions in suitable systems such as bioreactors223, from where they need to be efficiently processed, extracted and converted into industrial outputs of interest. The scope covers innovative multi-scale bioreactor designs, and related innovations such as hydroponics systems and phenotyping platforms for increased sustainability of biomass production, and its efficient, pathogen-free processing and use.

Where relevant, proposals should seek links with and capitalise on the results of past and ongoing research projects (under Horizon 2020 and other EU-funded initiatives). Proposals should:

a. Develop bio-based production platforms applying resource-efficient principles (ensuring savings on water, energy, chemical inputs, biomass side-streams or residues), including the study of mixed multi-species communities, and applying modern biotechnological principles, as well as efficient separation and extraction approaches for products of interest.

b. Identify and implement the best combination of appropriate technical solutions and practices for specific industrial value chains (justifying the choice, including on business

viability), as well as the barriers and drivers derived from governance and market aspects, while seeking engagement and understanding of all actors. Participation of industry and SMEs is considered essential.

c. Develop and transparently communicate: (i) the key parameters to monitor and measure the qualitative and quantitative impacts of these solutions and practices for different optimization and production systems, (ii) the potential of replacing available traditional alternatives, if relevant, and trade-offs, including with respect to biodiversity, patient perspective, and (iii) the associated improvement of socio-economic resilience of the businesses for the jobs creation and industrial competitiveness.

d. Develop and test mechanisms involving all actors and specifically including the research community and bio-based industries in knowledge co-creation, exchange, feedback and communication to demonstrate and accompany all actors (e.g. civil society including patient and other related groups) to implement and understand of solutions for improved bio-based products and processes and to address other environmental impacts. Develop specific recommendations for policy makers, while seeking involvement of broader civil society.

e. Consider contribute data and results to the European Commission's Knowledge Centre for Bioeconomy hosted by the JRC.

For this topic, it is not mandatory to integrate the gender dimension (sex and gender analysis) into research and innovation.

Topic ID and title	HORIZON-CL6-2021-CircBio-01-07: Microbiomes for bio-based innovation and environmental applications				
Budget	EUR 6 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 6 million			**Deadline 2**	/
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	bio-based materials, biochemicals, molecular biology, biotechnology				
FTP comments					
FTP SIRA 2030 Challenges addressed	9A,B			**FTP relevance**	Low
				Starting TRL	/
				End TRL	6-7

Expected Outcome

Successful proposals should contribute to the impacts of this destination, and the European policies it supports, in particular the European Green Deal, the circular economy action plan and the bioeconomy strategy. They should help improve European industrial224 sustainability, competitiveness and resource independence by developing innovative bio-based products. They should engage all stakeholders and improve their knowledge and understanding of science, in particular biotechnology-based value chains, and increase benefits for consumers.

Project results should contribute to all of the following outcomes:

- Deeper understanding of the structural composition of microbiomes, their structure, functions, mechanisms, and potentials, as related to bio-based innovation (i.e. bio-based materials, biochemicals, products and services, including the environmental applications), as well as improved methods of their isolation and cultivation. This should lead to innovative solutions to engineer and control microbiomes and guarantee safety and efficacy for specific applications.
- Improved interdisciplinary cooperation on R&D&I between academia and industrial sectors (e.g. industrial biotechnology, food, pharma and ICT/data industries) and higher engagement of industry and SMEs.
- More systematic adoption of recent advances in molecular biology and biotechnology to increase industrial uptake of R&D&I on microbiota. This includes, in particular, their complex communities via biotechnology approaches, leading to more cost- and resource-efficient production of high-value complex molecules, lowering pressure on natural resources, or increasing their use in environmental applications.

- Greater and more inclusive understanding, awareness and trust in innovations, via societal dialogue and transparent communications with all stakeholders (academia, industry, including SMEs, NGOs, regulatory institutions, international partners etc.).

Scope

Microbiomes is the term given to the collective genomes of mixed nature-based microorganism populations. In recent years, scientific-technological progress in genome sequencing and other -omics technologies and in the bioinformatic analysis and interpretation of the data has opened up the opportunity to better understand the composition of (often difficult to cultivate with existing approaches) microbial communities, the functions and interaction of their members, and their interaction with their environment (e.g. soil) or hosts (humans, animals, plants).

The scope includes developing the methods for molecular cartography, the quantitative determination of genes and metabolites and establishing the R&D resources (e.g. inventories, catalogues, "reference microbiomes", databases etc.). Marine microbiomes are excluded from the scope, in order to avoid overlaps with the parallel topic225.

International cooperation is encouraged, as it can contribute to European competitiveness and resilience.

Proposals should:

a. Develop and apply a toolbox of technologies to identify, characterise and sustainably exploit (including isolation and cultivation aspects) the microbiomes and their genetic and metabolic diversity relevant for the bio-based sectors. Develop the related microbiome-based bioprocesses, e.g. to enable industrial manufacturing of high-value bio-based substances or materials (excluding biofuels/bioenergy applications), at sufficiently large scale, or for the environmental protection applications (e.g. decomposition of persistent and hazardous contaminants or industrial, municipal waste and residues).

b. b. Identify and characterise the key environmental and safety aspects, and potential impacts, while adhering to the binding EU and international regulatory framework.

c. c. Outline the scale-up production processes for novel bio-based innovations that are necessary to reach a critical mass for a given application, to achieve economies of scale, address different market segments and potential applications, etc. This includes addressing process and product safety, including occupational and consumer safety aspects, taking into account best international practice and initiatives.

d. d. Ensure the transparent and inclusive engagement of all actors, including industry and SMEs, the scientific community, regulatory institutions, and broader civil society, including NGOs, to ensure the necessary impact and awareness.

e. e. Where relevant, proposals should seek links with and capitalise on the results of past and ongoing research projects, including on food systems, health and industrial value chains, as related to microbiomes.

For this topic, it is not mandatory to integrate the gender dimension (sex and gender analysis) into research and innovation.

Topic ID and title	HORIZON-CL6-2021-CircBio-01-08: Mainstreaming inclusive small-scale bio-based solutions in European rural areas				
Budget	EUR 9 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 3 million			**Deadline 2**	/
Type of action	Coordination and Support Action (CSA)				
FTP subsector	WW, P&P				
Keywords	Bio-based innovations, rural areas, innovation support services, circular bioeconomy				
FTP comments					
FTP SIRA 2030 Challenges addressed	7C			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

Expected Outcome

In line with the European Green Deal objectives and the EU bioeconomy strategy, successful proposals will support innovators to scale-up inclusive and small-scale biobased solutions in rural areas contributing to regional, urban and consumer-based transitions towards a sustainable, regenerative, inclusive and just circular economy and bioeconomy across all regions of Europe at local and regional scale.

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

- Enhanced cooperation between the key players and knowledge holders resulting in sustainable business model pathways for bio-based innovations in rural areas;
- Provision of tailored and independent support to innovators in order to accelerate the development of marketable products and services and to improve the market penetration of bio-based solutions in Europe;
- Successful deployment of existing scientific and practical knowledge and more bio-based solutions introduced in rural areas in line with relevant policy initiatives (e.g. bioeconomy strategy, European Green Deal, common agricultural policy (CAP), long-term vision for rural areas, etc.).

Scope

Europe's future economic growth and job creations will increasingly stem from innovation in products, services and business models. This is why there is currently considerable investment in research and innovation. However, there are barriers to the adoption and implementation of research results and cooperation between research, advisory services, farmers, foresters and other actors in the supply chain is not adequately supported. Regional platforms for innovation support services are needed to help European regions develop their

bio-based economies and to increase awareness and knowledge about emerging opportunities as well as the environmental and socio-economic impacts relating to the valorisation of locally or regionally available biomass.

Proposals will:

- Establish regional platforms that provide innovation support services to multi-actor partnerships (e.g. farmers, foresters, clusters, business support organisations, social partners, civil society organisations including non-governmental organisations, etc.) and increase regional stakeholders' awareness and understanding of the bioeconomy, its potential and impacts, and help them build the capacity to identify innovative bio-based business models.
- Based on previous research results (e.g. BE-RURAL226, Power4Bio227, BioeastUp228, etc.), activities should help match information on regionally available biomass, waste and residue streams with market information and technologies to enable full utilisation and sustainable production of bio-based products.
- Help transfer training and knowledge on better nutrient recycling in the circular bioeconomy, by identifying links between different agricultural/forestry and industrial value chains, raising awareness and sharing best practice on the use of residues as soil improvers and fertiliser in the bio-based economy.
- Consider contributing data and results to the European Commission's Knowledge Centre for Bioeconomy hosted by the JRC.

Clustering and cooperation with other selected projects under this topic and other relevant topics (e.g. HORIZON-CL6-2021-COMMUNITIES-01-02: Expertise and training centre on rural innovation) is strongly encouraged.

Social innovation229 is recommended when the solution is at the socio-technical interface and requires social change, new social practices, social ownership or market uptake.

Call – Circular economy and bioeconomy sectors 2022

Innovating sustainable bio-based systems and the bioeconomy

Topic ID and title	HORIZON-CL6-2022-CircBio-01-03: Benefits of the transition towards sustainable circular bio-based systems from linear fossil-based				
Budget	EUR 4 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 2 million			**Deadline 2**	/
Type of action	Coordination and Support Action (CSA)				
FTP subsector	F&F, WW, P&P				
Keywords	Environmental impact, social impact, economic impact, waste production, non-renewable resources, biodiversity loss, land use, ecosystem services, scenarios comparison, nature-based solutions (NBS), bio-based solutions				
FTP comments					
FTP SIRA 2030 Challenges addressed	4			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

Expected Outcome

Successful proposals will support policy makers in their efforts to develop sustainable pathways to replace fossil and carbon-intensive systems with circular bio-based systems at the EU and regional scale, in line with the 2030 climate targets and European Green Deal objectives. Project outcomes will contribute to foster European industrial sustainability, competitiveness and resource independence.

Projects results are expected to contribute to the following expected outcome:

- Policies are designed to enable the transition from linear fossil-based systems to circular bio-based systems, setting priorities.

Scope

Abandoning the current linear fossil-based economy is a prerequisite for European Green Deal objectives and, in general, for preserving life on our planet. Biogenic resources are key means of mitigating climate change as they can strengthen natural and anthropogenic carbon sinks. Circular bio-based systems are part of the solution to achieving climate neutrality, where they replace carbon-intensive and fossil-based systems and are based on sustainably sourced biological resources. Policies must ensure that this transition from linear fossil-based to circular bio-based systems is sustainable and aims at i) climate change mitigation and adaptation; ii) increasing resource efficiency and circularity; iii) preserving and restoring natural resources, their ecosystem services and biodiversity; and i) ensuring a just transition for everyone. Policies and priorities should be comprehensive and underpinned

by a critical assessment of the environmental/social/economic impacts of the current linear fossil-based economy. That assessment should help individuating policy priorities, as well.

To support designing policies to transition away from linear fossil-based systems towards sustainable circular bio-based ones, proposals should:

a. Consolidate knowledge on current trends in terms of the environmental, economic and social limits of a linear carbon-intensive and fossil-based economy. By limits, we mean technical and structural barriers and/or inability to reach local and global Sustainable Development Goals (e.g. SDGs, climate change mitigation targets, European Green Deal objectives). Cultural and social limits should also be considered, including barriers related to gender and age.

b. Develop new/improve existing methodologies to assess environmental/social/economic impacts of linearity vs circularity in the economy, including on waste production and disposal, non-renewable resources exploitation and loss, geographically (and socially) unbalanced distribution of resources and growth, biodiversity loss at global and local scale. The methodologies should consider circular economy indicators, methods and concepts developed or under development in existing initiatives, including Commission's ongoing work on the circular economy monitoring framework and R&I activities.

c. Assess the environmental/social/economic impacts of the EU's current linear fossil-based economy. This should include aspects related to the geographical distribution of oil origins and global trade, direct and indirect environmental impacts of fossil-based value chains on a life cycle base, including on, but not limited to, climate change, resource use including land, water and marine space, air/water/soil quality, ecosystems services and biodiversity. Costs arising from environmental and social impacts should be internalised in the economic impacts assessment.

d. Develop and compare multiple scenarios of transitioning from fossil-based to circular bio-based systems, modelling the replacement of the fossil-based activities, with a focus on the most carbon-intensive ones, with bio-based systems, including innovative solutions, at EU and global scale. Environmental/social/economic impacts of bio-based systems should be assessed with validated methodology, considering also the benefits of applying a circular approach to the bio-based systems. Biogenic carbon capture utilization (BCCU) solutions 239 for bio-based systems via nature-based solutions (e.g. in soils or long-term circular bio-based materials) should be part of the assessment. Scenarios should compare the impacts of fossil-based and bio-based solutions, and include social aspects and social innovation, especially at the socio-technical interfaces of innovative solutions.

e. Identify knowledge gaps in the assessment of the sustainability of the transition from fossil-based to circular bio-based systems and in the comparison between alternative scenarios as described under point d).

f. Identify priorities in the transition from fossil-based to circular bio-based systems, according to scenarios analysed in the project and develop guidelines and policy recommendations.

Proposals should include a task dedicated to sharing methodologies and findings with projects funded within this topic.

This topic should involve the effective contribution of social sciences and humanities (SSH) disciplines.

Safeguarding the multiple functions of EU forests

Topic ID and title	HORIZON-CL6-2022-CircBio-01-06: Strengthening the European forest-based research and innovation ecosystem				
Budget	EUR 4 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 4 million			**Deadline 2**	/
Type of action	Research and Innovations Actions (RIA)				
FTP subsector	F&F, WW, P&P				
Keywords	EU Forest Strategy, open-innovation ecosystem, funding possibilities, trans-national R&I cooperation, R&I roadmap, multifunctionality of forest, forest management, multi-actor approach				
FTP comments					
FTP SIRA 2030 Challenges addressed				**FTP relevance**	High
				Starting TRL	/
				End TRL	/

Expected Outcome

To support the new EU forest strategy, successful proposals will assess research needs and funding possibilities for forestry and the forest-based sector, notably for the multifunctionality and management of forests in Europe based on the three pillars of sustainability (economic, environmental and social). Project results are expected to contribute to all of the following expected outcomes:

- Better insights into existing funding sources (including Horizon Europe, rural and regional development funds) and streamlining of research and innovation (R&I) actions in Europe.
- Establishment of a co-creative environment allowing stakeholders to identify jointly existing research gaps and future priorities to coordinate research efforts at regional, national and European level.
- Intensified trans-national R&I cooperation in forestry and the forest-based sector on research priorities, critical and key technologies.
- Creation of an open-innovation ecosystem with relevant stakeholders in the EU and associated countries to support the evolution of the forest-based sector.

Scope

A key R&I challenge for the coming years is to address the complexity of the forest-based sector in environmental terms (long life cycle, ecosystem functioning and diversity, spatial variability, interface between the soil and the atmosphere, in the middle between cultivated and natural assets), economic terms (multiple forest owners and SMEs, competitiveness on

global markets) and policy terms (many forest-related policies including biological diversity, climate and energy, bioeconomy, rural development, trade, agriculture, etc.).

A successful transition of the forest-based sector towards greater sustainability needs to be underpinned by a comprehensive scientific assessment. Better coordination of research activities is also required to overcome fragmentation of public research efforts, to strengthen the link between forest managers, industries and society and to streamline the activities of European, national and regional stakeholders.

Proposals will:

- Analyse the forest-based sector in an integrated way, considering different biodiversity and bioeconomy issues, societal expectations and climate change risks that call for an intensified European and international collaboration.
- Design a suitable method for conducting foresight analysis on issues that are likely to have an impact on forests in European regions and globally.
- Consider the future availability of and demands for different forest resources, and assess their sustainability within the changing global economic, social and environmental conditions.
- Provide evidence and knowledge on how existing funding sources at EU (including Horizon Europe, rural and regional development funds), Member State, associated countries' and regional levels are mobilised to support research and innovation initiatives in the forest-based sector.
- Address the necessity for new knowledge to support major transitions and innovations in forestry and the forest-based sector in view of the new EU forest strategy and other major policy initiatives.
- Develop a structured framework for a European network of research funding and research policy organisations across the different parts of the forest-based and related sectors to increass cross-fertilisation between different areas of knowledge generation and innovation activities.
- Develop an R&I roadmap at EU-level and prepare for a possible European partnership or other appropriate comprehensive actions under Horizon Europe.
- Provide scenarios and information on how to maximise synergies and minimise trade-offs between the different funding instruments and research needs (environmental, economic and social dimensions)

- Assess the potential of flagship projects in selected key strategic areas in the forest-based sector (e.g. integrated forest research across several dimensions of sustainable forest management; landscape-level integration of forest research at the interface with other sectors (agriculture, cities, water); increased, sustainable wood production and mobilisation; renewable building materials for healthier living; role of new wood-based products to reach climate neutrality by substitution effects; contributions of the forest-based sector in the green recovery).

Proposals must implement the 'multi-actor approach' and ensure a value chain approach, with adequate involvement of the forestry and forest-based sector.

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 – Circular economy and bioeconomy sectors 2022 two-stage

Innovating sustainable bio-based systems and the bioeconomy

Topic ID and title	HORIZON-CL6-2022-CircBio-02-03-two-stage : Sustainable biodegradable novel bio-based plastics: innovation for sustainability and end-of-life options of plastics				
Budget	EUR 12 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 6 million			**Deadline 2**	01 September 2022
Type of action	Innovation Actions (IA)				
FTP subsector	P&P				
Keywords	Bio-based innovation, bio-based plastics, green chemistry, biodegradability				
FTP comments					
FTP SIRA 2030 Challenges addressed	4 - 9			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	7-8

Expected Outcome

Successful proposals will support the uptake of bio-based innovation with high environmental and functional performance of products, processes and services along value chains and life cycles by bio-based industry, in line with European Green Deal objectives. Project outcomes will contribute to foster European industrial sustainability, competitiveness and resource independence, by lowering the environmental footprint and enabling climate-neutrality and higher resource efficiency along value chains.

Projects results are expected to contribute to the following expected outcome:

- Bio-based plastics value chains are deployed with improved functionalities and environmental performances, less toxicity substances, lower waste production and better product safety control along the whole value chain.

Scope

There is a need to develop innovative, sustainable bio-based and biodegradable plastics with novel properties and production processes to deliver environmentally friendly materials with the desired properties for long-term circular applications, markets and uses. The approach should combine environmental sustainability, circularity and functionality of the developed products and of the supply chain. Results should be aligned to recent policy developments on plastics.

Proposals should:

a. Develop novel sustainable bio-based biodegradable plastics with enhanced functionalities, circularity and environmental sustainability, based on their non-toxic nature and improved end-of-life behaviour, for specific applications. The bio-based plastic should be mechanically recyclable and its biodegradability in specific environments should allow for a more sustainably managed end-of-life such as either composting or anaerobic digestion or home composting or in 'in-situ' degradation (i.e. natural soil and marine environments) depending on applications and conditions.

b. Develop and optimise innovative aspects of the production process, for example green chemistry and/or fermentative production, especially with respect to catalysts, higher yield, bio-based plastic quality, while ensuring the sustainability of biological feedstock used in the manufacturing, including biological waste and residues, and of production processes, aiming at a low environmental footprint and economic viability.

c. Test the biodegradability in the specific environment where the bio-based plastic developed for selected applications and conditions could end its life cycle, i.e. either composting plant or anaerobic digester, or home composting, or in 'in-situ' degradation (i.e. natural soil and marine environments);

d. Consider process and product safety (i.e. production through to the use of a product) in value chains, especially for new products and materials, following national or EU regulations. The toxicological evaluation of products and the EU regulatory requirements for product safety should be systematically addressed as part of proposals/projects, in particular where uses may be linked to critical exposure routes (e.g. food contact materials).

e. Demonstrate the scaled-up production processes and cost competitiveness for novel sustainable bio-based biodegradable plastics in order to reach a critical mass for a given bio-based plastic, to achieve economies of scale.

Proposals should include a task dedicated to sharing methodologies and findings with projects funded within this topic. Where relevant, proposals should seek links with and to capitalise on the results of past and other ongoing research projects. They should take a multidisciplinary approach, involving many stakeholders and fields of applications and considering various aspects along the bio-based plastics value chain, including EU rules on product safety. They should also consider contributing data and results to the European Commission's Knowledge Centre for Bioeconomy hosted by the JRC.

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

Safeguarding the multiple functions of EU forests

Topic ID and title	HORIZON-CL6-2022-CircBio-02-06-two-stage: Harnessing the digital revolution in the forest-based sector				
Budget	EUR 15 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 6 to 8 million			**Deadline 2**	1 September 2022
Type of action	Innovations Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	EU Forest Strategy, digital solutions, ICT innovations, ecosystem services, forest resources, wood value chain, precision forestry, harvesting systems, nurseries, harvest planning, operations management, timber transport, Copernicus, Galileo/EGNOS pests, forest fires, multi-actor approach				
FTP comments					
FTP SIRA 2030 Challenges addressed	2B,D - 8C - 9D - 10C,D			**FTP relevance**	High
				Starting TRL	/
				End TRL	6-7

Expected Outcome

line with the EU forest strategy and the European digital strategy, successful proposals will demonstrate the potential of digital solutions in forestry and forest-based value chains contributing to the multifunctionality and management of forests in Europe based on the three pillars of sustainability (economic, environmental and social). Project results are expected to contribute to all of the following expected outcomes:

- Deployment of information and communication technology (ICT) innovations in forestry to optimise productivity as well as the delivery of ecosystem services.
- Application of innovative approaches along the forest-based value chain by more accurate tracing methodologies of forest resources.
- A greater competitive advantage for European industries that utilise forest resources more efficiently.

Scope

The improved use of information flows and intelligent digital solutions that are increasingly available in forest monitoring, management and forestry operations, could help to significantly improve and unlock the efficiency of wood supply chain activities. Modern digital applications also provide promising possibilities to improve forest managers' decision making in a precious and complex forest environment and to improve ecosystem monitoring.

This topic addresses innovations in information systems for forest managers, forest-based industries and policy makers as well as advances in precision forestry, harvesting systems and forest nursery operation, optimised harvest planning, operations management, timber transport and logistics, as well as safety, ergonomics and smart assistance for human workers. The synergetic use of geo-spatial, statistical, and modelling technologies together with information and communication technologies such as aerial and satellite retrievals, (in particular from the Copernicus programme) and the 'web of things' combined with big-data analytics is highly encouraged.

The aim is to harness the potential of ICT and new technologies to improve the sustainability of forest management and logging operations with a view to sharing data throughout the wood value chain, thereby driving greater sustainability, to offer new business models along the value chain and to improve the traceability of forest resources for optimised and transparent supply chains. The integration in the new technologies of climate change impacts on these wood chains should be an essential component. Activities may also include robust and transparent methods and tools for high resolution forest and ecosystems services assessments, natural disturbance risk monitoring and analysis (including pests and forest fires) and disaster response systems.

Besides activities such as prototyping, testing, demonstrating and piloting in a near to operational environment, proposals may include limited research activities. Assessing and deepening the understanding of economic, social and environmental impacts through an enhanced application of digital technologies for foresters, small and medium-sized enterpirses (SMEs) and industries, as well as end-consumers will be of special interest, including the assessment of risks and opportunities for jobs in forestry, the wider forest-based sector and rural communities.

Proposals must implement the 'multi-actor approach' and ensure adequate involvement of the primary sector and the wider forest-based value chain. Cooperation with other selected projects under this topic and other relevant projects is strongly encouraged.

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

Destination 4: Clean environment and zero pollution

Anthropogenic pollution undermines the integrity of Earth ecosystems and severely affects natural resources essential for human life. Keeping our planet clean and our ecosystems healthy will not only contribute to addressing the climate crisis but also help regenerate biodiversity, ensure the sustainability of primary production activities and safeguard the well-being of humankind. In line with the objectives of the European Green Deal, particularly its zero pollution ambition, and the 2030 Climate Target Plan, and other relevant EU legislation260, this destination seeks to halt and prevent pollution by focussing the work programme 2021-2022 on fresh and marine waters, soils, air, including from nitrogen and phosphorus emissions, as well as on the environmental performance and sustainability of processes in the bio-based systems. Synergies with other clusters (notably 1 and 5), relevant destinations as well as missions and partnerships will be exploited.

Halting emissions of pollutants to soils and waters is of fundamental significance for the planet. Diffuse emissions of pollutants from land and urban sources, including atmospheric depositions, are a major stress factor for terrestrial and aquatic ecosystems, threatening the quality of surface waters and aquifers, and affecting soil quality and all water-dependent sectors that require a holistic understanding of the pollution sources, key vectors and pathways. Projected impacts of climate change will alter, and notably reduce, the hydrological flows in many parts of Europe, while eutrophication could be exacerbated by increasing temperatures. Climate change and increasing water demand will exert significant pressures on surface and groundwater quality261, notably where the combined effect of water table depletion and sea level rise will endanger the integrity of coastal aquifers and groundwater quality. This is due to saline water intrusion or extreme events (e.g. higher tides, storm surges or inland flooding events), which will put coastal wetlands and reservoirs, estuaries and ecosystems at risk. While recognising its essential role in aquatic ecosystems functioning and services, the sediments originating mostly from run-off and erosion are likely the major source of physical pollution of water bodies (excessive turbidity, impacts of deposition, accumulation of litter and debris) and contribute to a large extent to chemical and biological pollution of receiving waters. Beside land use practises, the increasing intensity and variability of precipitation will exacerbate erosion risks, affect the deposition and transport of sediments and could lead to a remobilisation of legacy contaminants and further deteriorate the quality of soils, sediments and water bodies, including aquifers, estuaries and coastal areas, and of their ecosystem function and services.

Keeping nitrogen (N) and phosphorus (P) cycles in balance is another crucial challenge. N and P flows from anthropogenic sources, mostly from excessive or inefficient input of fertilisers (including manure, sewage sludge, etc.) in agriculture, currently exceed

planetaryboundaries. Their leaching and run-off negatively affect soil biodiversity, pH, organic matter concentration and carbon sequestration capacity, and cause the eutrophication of water bodies while ammonia and nitrous oxide emissions affect air quality and climate. As all environmental media are concerned, a systemic approach is necessary to limit N/P emissions from different sources, for example through the deployment of alternative fertilising products, and considering regional conditions (geography, climate zones, economy activities, soil properties, eco-system condition, agricultural practices, governance structures etc.), and to bring N/P flows back within safe ecological boundaries

Protecting drinking water and managing water pollution in rural settlements, and in increasingly dense urban areas requires innovative and holistic approaches at city/catchment level to ensure water quality, resilient to the impacts of climate and global change, by considering different spatial and temporal scales and contexts, aging water infrastructures, as well as pollution derived from point and non-point sources, and natural/human-made disasters. Protective measures should consider current and future land use, environmental needs and socioeconomic interests as essential elements for improving water quality and its management and governance. Re-emerging pollutants, such as polychlorinated biphenyls (PCB) or mercury, and contaminants of emerging concern (CECs) in water bodies may have impacts on ecological and human health, and some are not well regulated under existing environmental legislation. Sources of these pollutants include e.g. industry, agriculture, urban runoff, household products, coatings, paints and pharmaceuticals that are normally disposed of to sewage treatment plants and subsequently discharged into water bodies. Micro-pollutants, plastics, pathogens and CECs, individually or combined, represent a concern for a safe and good quality drinking water supply. Increasing water temperatures, notably due to climate change could deteriorate the quality of aquatic ecosystems and drinking water sources by favouring the conditions for enhanced eutrophication as well as pathogen development or the spread of invasive species. Emerging concerns are also growing at the level of drinking water treatment and distribution, notably in relation with disinfection operations and possible harmful effects of by-products and metabolites.

Addressing pollution on seas and ocean is a prerequisite for a healthy planet. The ocean is being polluted and destroyed due to the release of substances or energy in marine waters which initiate a range of subsequent effects. According to a new European Environment Agency report, all four regional seas in Europe have a large-scale contamination problem, ranging from 96% of the assessed area in the Baltic Sea and 91% in the Black Sea, to 87% in the Mediterranean and 75% in the North-East Atlantic Ocean. The main sources of pollution include industrial, agricultural and municipal waste runoff, other human activities (e.g. transport), underwater noise, light, atmospheric deposition, etc. into marine waters.

Increasing the environmental performance and sustainability of processes and products plays a significant role in keeping our planet clean. Environmental pollution resulting from human activity is detrimental to ecosystems at different functional levels, representing, also, an important economic burden for society. Circular bio-based systems, including biotechnology, have the potential to substantially contribute to the European Green Deal objectives, provided that they are developed sustainably and systemically aiming at mitigating the climate change and its impacts, increasing resource efficiency and circularity, preserving and restoring ecosystems services, natural resources, air/water/soil quality and biodiversity. Indicators of such sustainability are needed, building on dynamic perspectives at scales ranging, in space, from planetary to local ecosystems and, in time, from next decade to the end of century and beyond. Environmental impacts should be traced along value chains and trades to enable responsible production and consumption.

Expected impacts

Pollution must be halted and eliminated to guarantee clean and healthy soils, air, fresh and marine water for all. To reach this objective, it will be paramount to advance the knowledge of pollution sources and pathways to enable preventive measures, improve monitoring and control, apply planetary boundaries in practice and introduce effective remediation methods.

Proposals for topics under this destination should set out a credible pathway to contribute to the aforementioned goal to achieve a clean environment and zero pollution, and more specifically to one or several of the following impacts:

- Advanced understanding of diffuse and point sources of water pollution in a global and climate change context, enabling novel solutions to protect water bodies, aquatic ecosystems and soil functionality, and further enhancing water quality and its management for safe human and ecological use, while fostering the EU's and Associated Countries' position and role in the global water scene.
- Balanced N/P flows well within safe ecological boundaries at EU and Associated Countries, regional and local scale, contribute to restoring ecosystems.
- Clean, unpolluted seas in the EU and Associated Countries as a result of successful behavioural, social-economic, demographic, governance and green-blue transitions.
- Circular bio-based systems reversing climate change, restoring biodiversity and protecting air, water and soil quality along supply chain of biological feedstock and industrial value chains, within the EU and Associated Countries and across borders.
- Innovative biotechnology creating zero-pollution bio-based solutions.

When considering their impact, proposals also need to assess their compliance with the "Do No Significant Harm" principle262 according to which the research and innovation activities of the project should not be supporting or carrying out activities that make a significant harm to any of the six environmental objectives of the EU Taxonomy Regulation.

Actions should develop scientifically robust and transparent approaches and methodologies, building on achievements from previous research activities, where possible and appropriate. To ensure deployment, trustworthiness, swift and wide adoption by user communities, and to support EU and national policy-makers, they should adopt high standards of transparency and openness, going beyond ex-post documentation of results and extending to aspects such as assumptions, models and data quality during the life of projects.

Topics under this destination will address the following impact areas of the Horizon Europe strategic plan for 2021-2024: "Climate change mitigation and adaptation"; "Enhancing ecosystems and biodiversity on land and in waters"; "Good health and high-quality accessible healthcare"; "Clean and healthy air, water and soil"; "A resilient EU prepared for emerging threats"; and "Inclusive growth and new job opportunities".

Call – Clean environment and zero pollution 2021

Increasing environmental performances and sustainability of processes and products

Topic ID and title	HORIZON-CL6-2021-ZEROPOLLUTION-01-05: Environmental sustainability criteria for biological resources production and trade in bio-based systems: impacts and trade-offs				
Budget	EUR 6 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 6 million			**Deadline 2**	/
Type of action	Innovations Actions (IA)				
FTP subsector	F&F, WW, P&P				
Keywords	Certification, international trade, bio-based systems, primary biomass resources production, biological feedstock, secondary raw materials, environmental impacts, land use, GHG emissions, ecosystem services, biodiversity, energy consumption, life cycle, traceability				
FTP comments					
FTP SIRA 2030 Challenges addressed	1 - 2E			**FTP relevance**	Medium
				Starting TRL	/
				End TRL	7-8

Expected Outcome

The successful proposal will support tracing environmental impacts of biological resources production and trade by primary producers, traders and certification companies to enable responsible production in the industrial bio-based systems, in line with the 2030 Climate Target Plan and the zero pollution ambition. Project outcomes will contribute to establish circular bio-based systems reversing climate change, restoring biodiversity and protecting air, soil and water quality along supply chain of biological resources and industrial value chains, within the EU and across borders. Project results are expected to contribute to the following expected outcome:

- Certification schemes for international trade at EU and global scale of biological resources for bio-based systems include the environmental impacts and trade-offs along the bio-based supply chains.

Scope

Assessment of environmental sustainability of biological resources production and trades in the bio-based systems is still a challenge. Indicators of such sustainability should build on dynamic perspectives at scales ranging, in space, from planetary to local ecosystems and, in time, from next decade to the end of century and beyond.

Proposals should:

a. Identify the range of biological resources intended for industrial bio-based systems at EU and local (regional/rural/urban/coastal) scale, including primary biomass resources production and biological secondary raw materials from rural/urban/industrial activities. Industrial bio-based systems do not include food/feed, biofuels, bioenergy and cultural/recreation sectors. However, relevant initiatives in the field of assessment and certification of environmental sustainability of biological resources arising from EU policies in the bioeconomy sectors should be taken into account. Aspects of trade of biological resources within the EU and at global level should be part of the analysis.

b. Collect data and figures on volumes of biological resources identified under a) in global trade flows and imports into the EU and their geographic distribution. The data collection should be based on existing and consolidated statistics and market databases.

c. Improve existing and/or develop new methodology for the assessment of the environmental impacts and trade-offs of biological resources in the scope addressing, but not limiting to, the following environmental categories: i) GHG emissions/savings and carbon footprint; ii) emissions from nitrogen and phosphorous based fertilisers; iii) land use and land use change and its related impact on land carbon sink capacity; iv) marine space use and marine space use change; v) water use; vi) biodiversity and ecosystem services; vii) energy consumption, viii) any other aspects of air/water/soil environmental quality. Assessments should consider the life cycle perspective and relevant regulatory requirements in terms of trade (across and within the EU), to the extent possible. Trade-offs and synergies with food production, nature-based solution to protect biodiversity or other resources use and ecosystem services (e.g. recreation, urban creep) should be included in the assessment;

d. Align methodology in c) with indicators (e.g. environmental, demographic, geophysics indicators) provided by consolidated and available database, including networks of environmental observations, efficiently.

e. Adapt methodology in c) to be suitable to definition/identification of environmental sustainability criteria compliant with the format of certification schemes in terms of either adopting existing certification schemes or developing of ad hoc ones. Criteria should be aligned with the Commission's Taxonomy Regulation271. Traceability of biological resources at European and global scale should be essential part of certification.

f. Demonstrate the developed methodologies for the assessment of environmental impacts and trade-offs, sustainability criteria and certification schemes to a range of biological resources intended for industrial bio-based systems in an operational environment and deliver guidelines.

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

Proposals' consortia should involve primary producers of biological resources, trade bodies, bio-based industries, agencies/companies developing certification, consumers' organisations and any stakeholder along the supply chain of biological resources for bio-based industries.

Topic ID and title	HORIZON-CL6-2021-ZEROPOLLUTION-01-06: Increasing the environmental performance of industrial processes in bio-based sectors: construction, woodworking, textiles, pulp and paper and bio-chemicals				
Budget	EUR 7 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 3,5 million			**Deadline 2**	/
Type of action	Research and Innovation Actions (RIA)				
FTP subsector	WW, P&P				
Keywords	GHG emissions, carbon footprint, emissions to air/water/soil, water use, biodiversity, ecosystem services, bio-based processes, energy efficiency, resource efficiency, materials circularity, non-toxic substances, Life Cycle Assessment (LCA)				
FTP comments					
FTP SIRA 2030 Challenges addressed	5 - 8			**FTP relevance**	High
				Starting TRL	/
				End TRL	5

Expected Outcome

The successful proposal will support circular bio-based systems in industrial sectors in line with the European Green Deal and its zero pollution ambition and 2030 Climate Target Plan by increasing the environmental performance and sustainability of processes, and their ability to reverse climate change, restore biodiversity and protect air, water and soil quality along industrial value chains, within EU and across borders.

Project results are expected to contribute to the following expected outcome:

- Improvement of the environmental performance of industrial processes in the following bio-based sectors: construction, woodworking, textiles, pulp and paper, and bio-chemicals.

Scope

Proposals under this topic should focus on all of the following industrial bio-based sectors: construction, woodworking, textiles, pulp and paper, and bio-chemicals.

Proposals should:

a. Identify and analyse case studies for each aforementioned industrial bio-based sector at the local (regional, rural, urban or coastal) or international scale within the EU and Associated Countries, and collect data and figures on the environmental performance of industrial processes in these sectors.

b. Improve existing and/or develop new methodologies to assess the environmental impacts of these processes. The assessment should use, when possible, the Life Cycle Assessment methodology (in line with the existing international standards, the European Commission's

Product Environmental Footprint method272 and other relevant sources of information), and include, but not limited to, the following environmental impacts: GHG emissions and carbon footprint, emissions to air/water/soil, water and primary energy use, biodiversity and ecosystem services. The assessment methodology should also look at social and economic aspects. Relevant data may feed into the European Platform on Life Cycle Assessment273.

c. Assess and analyse the environmental impacts and trade-offs of bio-based processes identified in a) based on the methodology developed in b).

d. Identify and evaluate possible solutions to improve the environmental performance of bio-based processes based on c). The aspects to be evaluated include, but are not limited to the following: GHG emissions reduction, resource and energy efficiency, shift to renewable energy sources, enhanced circularity of materials (including upcycling and cascading use of biomass), non-toxic substances used in the processes, replacement of toxic substances with non-toxic ones, minimisation of residual waste at all phases of the processes, efficient recovery of any waste and residual flows.

e. Demonstrate, where possible, the best solutions identified under point d) in order to evaluate their effectiveness and assess monitoring procedures.

f. Develop recommendations and guidelines to improve the environmental performance of processes in each of the aforementioned industrial bio-based sector. These should include a prioritisation of solutions and recommendations for modifications in specific processes and preliminary indications for monitoring procedures.

Proposals should include a task dedicated to sharing methodologies and findings with projects funded within this topic. Moreover, they should build synergies with research and innovation projects funded under Horizon Europe notably under "HORIZON-CL6-2021-ZEROPOLLUTION-01-05: Environmental sustainability criteria for biological resources production and trade in bio-based systems: impacts and trade-offs", and where relevant, seek complementarities and capitalise on the results of other past and ongoing research projects (especially under the Bio-based Industries Joint Undertaking).

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

Topic ID and title	HORIZON-CL6-2021-ZEROPOLLUTION-01-07: International and EU sustainability certification schemes for bio-based systems				
Budget	EUR 6 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 2 million			**Deadline 2**	/
Type of action	Coordination and Support Action (CSA)				
FTP subsector	F&F, WW, P&P				
Keywords	Business-to-business (B2B), certification schemes, LCA, Labels for biobased materials, bio-based value chain transparency, circular bio-based systems, biodiversity restoration, bio-waste, secondary raw materials				
FTP comments					
FTP SIRA 2030 Challenges addressed				**FTP relevance**	Medium
				Starting TRL	/
				End TRL	/

Expected Outcome:

The successful proposals will support tracing environmental impacts along value chains and trades in the bio-based systems for business-to-business communication to enable responsible production and consumption, in line with the 2030 Climate Target Plan and the zero pollution ambition. Project outcomes will contribute to establish circular bio-based systems reversing climate change, restoring biodiversity and protecting air, soil and water quality along supply chain of biological resources and industrial value chains, within the EU and across borders.

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

- Bio-based value chains transparency in international and EU trade is enhanced through business-to-business labels of biological resources and bio-based materials and products.
- Harmonization of existing international and EU certification scheme and the monitoring system and indicators of their effectiveness and robustness.

Scope:

Climate neutral circular bio-based systems have the potential to establish a zero-pollution economy provided that they are developed sustainably. Environmental, social and economic impacts and trade-offs should be traced along value chains and trades to enable responsible production and consumption. Activities under this topic should assess scope, potential and requirements of international and EU sustainability certification schemes and business-to-business labels applicable to biological resources including primary biomass resources and bio-waste and residues intended for bio-based industrial value-chains and to bio-based materials and products, also in complementarity with actions on bio-based innovation and

market measures. Industrial bio-based systems do not include food/feed, biofuels, bioenergy and cultural/recreation sectors. However, relevant initiatives in the field of assessment and certification of environmental sustainability arising from EU policies in the bioeconomy sectors should be taken into account. Traceability of biological resources and bio-based materials and products on a business-to-business level, at the EU and the global scale, should be part of certification, including aspects on primary and secondary biomass and bio-based intermediates in global trade flows and imports into the EU.

Proposals should:

a. Review and analyse existing international and EU sustainability certification schemes and business-to-business labels for biological resources. The analysis should encompass schemes applied/applicable to biological resources intended for industrial bio-based value chains. Certified environmental, social and economic impacts and trade-offs should be analysed. Bio-waste and any biological secondary raw materials from rural/urban/industrial activities are included in the definition of biological resources.

b. Collect data and figures on volumes of biological resources and bio-based materials and products in global trade flows and imports into (exports from) the EU and their geographic distribution, distinguishing between certified and uncertified resources and materials/products. The data collection should be based on existing and consolidated market databases.

c. Review and analyse existing international and EU sustainability certification schemes and business-to-business labels for bio-based materials and products with the same level of detail apply to the analysis of resources (point a).

d. Assess existing/develop new monitoring system and indicators of effectiveness and robustness of existing certification schemes and labels reviewed in point a) and c). The task should consider the life cycle analysis perspective and identify minimum requirements of a certification scheme to ensure its completeness covering environmental, social and economic aspects.

e. Demonstrate/test effectiveness of existing (voluntary) certification schemes and labels and monitor their robustness; this action includes testing the monitoring system and indicators assessed/developed within the project, point d, on the reviewed schemes, point a) and c). The results should consolidate the optimal monitoring system and indicators and provide a preliminary selection of (parts of) the certification schemes covering the minimum requirements identified in point d). The same for labels.

f. Assess costs from the adoption of certification schemes and labels in selected industrial bio-based value-chains. The assessment includes selecting a range of value-chains in the EU and Associated Countries and the corresponding biological resources and flows of materials and products among those certified and reviewed in point a and c and collecting data and figures on the known costs: actual economic and internalised environmental and social ones. The evaluation of the externalised environmental and social costs should be part of the overall assessment, based either on primary data or/and on models taken from peer-reviewed literature in the related fields of economy, social and environmental sciences.

g. Evaluate the feasibility of business-to-business labels that award best performances either of resources or material or products from either environmental or social aspects. The feasibility should include modelled economic costs and benefits.

h. Analyse and develop recommendations on how to promote the best practices in the adoption of effective and robust certification schemes and business-to-business labels. Promoting actions may include deployment and take-up by industrial sectors of certification schemes, building trust between business stakeholders, deploying corporate responsibility, engagement with and awareness of bio-based sectors.

i. Engage in cooperation with international partners and organisations, to increase impact and outreach, while ensuring sufficient focus on the EU's situation.

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

Proposals should include a task dedicated to sharing methodologies and findings with projects funded within this topic. Proposals' consortia may include, but not be limited to, experts in certification schemes and stakeholders of the international and EU trade of biomass resources and bio-based materials and products.

This topic should involve the effective contribution of SSH disciplines.

Destination 7: Innovative governance, environmental observations and digital solutions in support of the Green Deal

Transformative changes such as the ones required within the Green Deal are dynamic processes that require appropriate governance. At the same time, to ensure coordination and for collaborative decision-making, governance requires multiple channels and networks that provide readily available data and information coming from different sources.

R&I activities under this destination aim at both: experimenting with new ways to govern the transition process and modernising the governance, in particular by making information and knowledge available and accessible. R&I for governance to support the Green Deal shall provide insights into institutional barriers such as lock-ins, path dependency, political and cultural inertia power imbalances and regulatory inconsistencies or weaknesses.

Innovative governance supporting the Green Deal objectives needs to recognise, cope with and promote resilience in the face of on-going shocks and disruptions both globally and across Europe, whether these be climatic, ecological, economic, social, geo-political or related to health. Critical risk assessment and reduction strategies need to be incorporated, including the diversification of infrastructures, resources and knowledge through more self-sufficiency and autonomy.

Taking advantage of the use, uptake, deployment and exploitation of environmental observations382 as well as digital solutions, assessed through the "do not harm" principle of the Green Deal, is key for innovative governance models and a more science-based policy design, implementation and monitoring. To maximise impacts of R&I on the ground and spark behavioural and socio-economic change, the knowledge and innovation produced throughout the whole cluster should be widely disseminated to key stakeholders of the relevant sectors of the cluster. In particular, the Agricultural Knowledge and Innovation Systems (AKIS) needs to be reinforced to accelerate the required transformative changes.

Data and information obtained through Environmental Observation is of great value when assessing the state of the planet and is delivering crucial information to support the Green Deal and the climate and ecological transition. Integration of this information from different sources (space-based, airborne including drones, in-situ and citizens observations) with other relevant data and knowledge while ensuring (better) accessible, interoperable or deployable information, delivers information necessary for shaping the direction of the development of policies in the broad context of Cluster 6 of Horizon Europe. A strong link to the European Earth observations programme Copernicus (in Cluster 4) and the European Space Agency's (ESA) Earth observation programme, as well as support to the Group on Earth Observations (GEO), its European regional initiative (EuroGEO) and the Global Earth

Observation System of Systems (GEOSS) is foreseen for topics on environmental observations under this destination. R&I activities relevant to ocean, seas and coastal waters will complement and support the UN Decade of Ocean Science for Sustainable Development and UN Decade on Restoration, the G7 Future of the Seas and Oceans Initiative, the pan-Commission Destination Earth initiative, the European Global Ocean Observing System (EOOS) and the GOOS 2030 strategy.

Digital innovation, in complementarity with Cluster 4 and Digital Europe Programmes activities, should bring benefits for citizens, businesses, researchers, the environment, society at large and policy-makers. The potential of the ongoing digital transformation, and its wider impacts, positive and negative, need to be better understood and monitored in view of future policy design and implementation, governance, and solution development

This destination will develop innovative digital and data based solutions to support communities and society at large, and economic sectors relevant for this cluster to achieve sustainability objectives. R&I activities will add value to the knowledge and cost-effectiveness of innovative technologies in and across primary production sectors, food systems, bioeconomy, ocean and biodiversity.

Knowledge and advice to all actors relevant to this cluster are key to improve sustainability. For instance, primary producers have a particular need for impartial and tailored advice on sustainable management choices. Knowledge and Innovation Systems are key drivers to enhance co-creation and thus speed up innovation and the take-up of results needed to achieve the Green Deal objectives and targets. This will include promoting interactive innovation and co-ownership of results by users, as well as strengthening synergies with other EU Funds in particular the CAP, reinforcing the multi-actor approach and setting up structural networking within national/regional/local AKISs. AKIS goes beyond agriculture, farming and rural activities and covers environment, climate, biodiversity, landscape, bio-based economy, consumers and citizens, i.e., all food and bio-based systems including transformation and distribution chains up until the consumer.

Expected impact

Proposals for topics under this destination should set out a credible pathway to contributing to innovative governance and sound decision making in policy for the green transition, and more specifically to one or several of the following impacts:

- Innovative governance models enabling sustainability and resilience notably to achieve better informed decision-making processes, societal engagement and innovation;

- Green Deal related domains benefit from further deployment and exploitation of Environmental Observation data and products ;
- A strengthened Global Earth Observation System of Systems (GEOSS)383;
- Sustainability performance and competitiveness in the domains covered by Cluster 6 are enhanced through further deployment of digital and data technologies as key enablers;
- More informed and engaged stakeholders and end users including primary producers and consumers thanks to effective platforms such as Agriculture Knowledge and Innovation Systems (AKIS)
- Strengthened EU and international science-policy interfaces to achieve the Sustainable Development Goals

When considering their impact, proposals also need to assess their compliance with the "Do No Significant Harm" principle384 according to which the research and innovation activities of the project should not be supporting or carrying out activities that make a significant harm to any of the six environmental objectives of the EU Taxonomy Regulation.

Topics under this destination will have impacts in the following areas: "Climate change mitigation and adaptation"; "Clean and healthy air, water and soil"; "Enhancing ecosystems and biodiversity on land and in water"; "Sustainable food systems from farm to fork on land and sea"; "High quality digital services for all"; and "A Competitive and secure data-economy".

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 – Innovative governance, environmental observations and digital solutions in support of the Green Deal 2021

Innovating with governance models and supporting policies

Topic ID and title	HORIZON-CL6-2021-GOVERNANCE-01-09: Revitalisation of European local communities with innovative bio-based business models and social innovation				
Budget	EUR 5 million	**Opening date**	22 June 2021	**Deadline 1**	06 October 2021
Budget per project	EUR 2,5 million			**Deadline 2**	/
Type of action	Coordination and Support Actions (CSA)				
FTP subsector	F&F, WW, P&P				
Keywords	local communities revitalisation, local bio-based economy, ecosystem services, recreation, sustainable biomass production				
FTP comments					
FTP SIRA 2030 Challenges addressed	3			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

Expected Outcome:

Successful proposal(s) will contribute to the expected impacts of Destination 'Innovative governance, environmental observations and digital solutions in support of the Green Deal', and the European policies it supports, in particular the European Green Deal, and EU bioeconomy strategy, by supporting the establishment of the innovative governance models notably to achieve better-informed decision-making processes, social engagement and innovation. In addition, the topic supports the strengthened EU and international science-policy interfaces to achieve the Sustainable Development Goals.

Projects results are expected to contribute to all following expected outcomes:

- Higher awareness of stakeholders (e.g. by development of a programme that focuses on helping local stakeholders, including primary biomass producers, civil society organisations including NGOs and SMEs to be integrated in and benefit from bio-based value chains) – identifying local actors and improve communication between them, showing opportunities for collaboration along the bio-based value chain.
- Increased opportunities to develop skilled jobs and small-scale establishments in the bioeconomy, thus helping to revitalise local communities (by supporting the local and regional rural development, economic and implementing authorities, to raise awareness of bio-based options)

- Advancement of the role of 'social enterprise' model for local communities, including the low-income populations, benefiting from creativity linked to bio-based solutions and promoting inclusiveness and cooperation at all levels.
- Increased opportunities created by the local bio-based economy within broader bioeconomy transition, e.g. by linking valorisation of ecosystem/nature services' (e.g. recreation) with sustainable biomass production, processing, product design and manufacture, circular use and upcycling to new applications.
- Supporting the development of for small businesses and for business-to-consumers communication of innovation, climate-neutrality and low environmental footprint/benefits/trade-offs and performances of bio-based products and services (e.g. by development of best practice guidelines);
- Supporting novel business models and related social measures to enable consumers, industry and public bodies to switch to socially and environmentally responsible behaviour within their choices (e.g. guidelines on regulatory measures, corporate responsibility initiatives, education); ensuring synergies, transparency and inclusiveness of all actors)

Scope:

The action advances the role and impact of bio-based innovation to accelerate the transition from a linear fossil-based economy, which leads to overuse and depletion of natural resources, into a resource-efficient and circular bio-based systems operating safely within planetary boundaries. Improved and informed governance and especially social innovation contributes to reducing resource consumption and results in an increased innovation capacity of all actors, while reducing the risk of leaving anyone behind, particularly in the areas and communities in need of revitalisation. This also helps to advance innovation at local scale and engage all actors (especially the 'social enterprise' model relevant for vulnerable populations).

Proposals should benefit from social creativity and opportunities at regional scale unleashed for bio-based systems, ensuring their low environmental footprint, in terms of feedstock, resources, processes, materials and products. Impacts and trade-offs, such as the carbon footprint and environmental footprint of the whole value chains should be part of the assessment of the bio-based systems. The proposals should seek complementarities with related actions392, under rural development programs on the governance of bio-based innovation and ensure inclusiveness and engagement of all actors.

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. Proposal could explore intersectionality approaches and consider aspects like gender, ethnicity, migrant or refugee status, social class, sexual orientation and disability to ensure inclusion of marginalised groups in citizen engagement and the development of tools and guidelines.

Proposals should:

a. select a range of bio-based systems where value chains can be tailored to specific needs in respect to the revitalisation of local communities (understood both in territorial and social sense), to their environmental and social impacts (benefits and trade-offs) from trade in the primary materials to the final products;

b. focus on relevant new or updated business models and local capacities (feedstocks, infrastructure, human skills, etc), and innovation actors (including community knowledge and marginalised groups), to enable sufficient impacts/benefits/positive trade-offs and performances of the specific value chains;

c. assess existing/develop new monitoring system and indicators of the effectiveness and robustness of existing governance schemes, to allow replication across Europe (e.g. income generation for all stakeholders, labour conditions, environmental indicators, social engagement, innovation parameters etc);

d. ensure efficient engagement of all actors (public authorities, SMEs, NGOs, knowledge providers) via robust and transparent communication and awareness-rising campaigns;

e. analyse social and economic barriers and potentialities to enable the transition towards socially and environmentally responsible behaviour within all ranges (e.g. regulatory measures, corporate responsibility initiatives, education), ensuring inclusiveness of all actors (NGOs, civil society etc).

Call – Innovative governance, environmental observations and digital solutions in support of the Green Deal 2022

Innovating with governance models and supporting policies

Topic ID and title	HORIZON-CL6-2022-GOVERNANCE-01-04: Consumer-focused labelling options for bio-based products				
Budget	EUR 3 million	**Opening date**	28 October 2021	**Deadline 1**	15 February 2022
Budget per project	EUR 3 million			**Deadline 2**	/
Type of action	Coordination and Support Actions (CSA)				
FTP subsector	WW, P&P				
Keywords	traceability, carbon footprint, transparency, business-to-consumers labels, bio-based systems, climate-neutrality, feedstock, bio-waste, certification, digital solutions				
FTP comments					
FTP SIRA 2030 Challenges addressed	1E			**FTP relevance**	Low
				Starting TRL	/
				End TRL	/

Expected Outcome

The successful proposal will support the deployment of business-to-consumers communication by producers and traders of bio-based products to enable responsible production and consumption in line with the objectives of the European Green Deal, the EU bioeconomy strategy and the European Climate Pact. Project outcomes will contribute to improve the sustainability performance and competitiveness in the bio-based systems and to the establishment of the innovative governance models notably to achieve better-informed decision-making processes, social engagement and innovation. Project results are expected to contribute to all of the following expected outcomes:

- Transparency of bio-based products and information to consumers and public authorities are provided through effective and robust business-to-consumers labelling on product traceability, quality, carbon footprint, biodiversity impacts and other environmental footprints.
- Consumers, industry and public bodies are enabled to switch towards socially and environmentally responsible behaviour within their choices in a transparent and inclusive way.
- Improved understanding of metrics on value generated per unit of biological resources.

Scope

The project is expected to advance the role and impact of bio-based innovation to accelerate the transition from a linear fossil-based economy, which leads to overuse and depletion of natural resources, into resource-efficient and circular bio-based systems operating within safe planetary boundaries. Improved and informed governance and social innovation contribute to reducing resource consumption and result in an increased innovation capacity of all actors. Informed consumers may pursue the objectives of circular economy, asking for efficiency and inclusiveness of services provided through less resources and goods, changing consumption patterns (e.g. reducing meat consumption), preventing food waste and separating bio-waste from other waste streams so that it can be (partly) converted to bio-based materials.

Proposals will focus on consumer-oriented labelling options for industrial bio-based products with low environmental footprint, in terms of resources, processes and materials used. Industrial bio-based products do not include food/feed, biofuels, bioenergy and cultural/recreation sectors. However, relevant initiatives in the field of consumer-focussed labelling of sustainability of bio-based products, arising from EU policies in the bioeconomy sectors, should be taken into account.

Proposals should:

a. Select a range of bio-based systems where value chains can be monitored in their environmental and social impacts (benefits and trade-offs) from the primary materials trade to the final products.

b. Develop pre- and co-normative research to design or update standards and labels for business-to-consumers communication of climate-neutrality and environmental impacts/benefits/trade-offs and performances of materials and products. Environmental impacts should include carbon footprint, climate neutrality, biodiversity impacts and any other environmental footprint relevant for the specific bio-based value chain and final products. Metrics on value generated, in the final product, per unit of biological feedstock used, including bio-waste, will be assessed.

c. Develop guidelines on the design of labels for bio- based products that include the perspectives of public authorities (national, regional, local) and consumers.

d. Assess existing/develop new monitoring system and indicators of effectiveness and robustness of existing business-to-consumers labels and certification schemes.

e. Demonstrate/test effectiveness of existing (voluntary) business-to-consumers labels and certification schemes and monitor robustness. This action includes the identification of

labels and certification schemes and testing of the monitoring system and indicators assessed/developed.

f. Assess costs and benefits from the adoption of business-to-consumers labels and certification schemes in selected bio-based systems.

g. Assess and develop smart options for the consumers in the digital age (e.g. mobile applications) aiming at sound understanding and practical use in support of and complying with the current relevant legal framework.

h. Analyse social measures to enable consumers to switch towards socially and environmentally responsible behaviour within their choices (e.g. regulatory measures, corporate responsibility initiatives, education), ensuring inclusiveness of all actors (NGOs, civil society etc) and taking into account differences between gender, age and socio-economic background.

The proposals should seek complementarities with related actions on bio-based innovation and market measures478, e.g. synergies with the food systems if appropriate479 or any other sector, and ensure inclusiveness and engagement of all actors along bio-based value chains.

This topic should involve the effective contribution of SSH disciplines.