Destination 1: Climate neutral, Circular and Digitised Production

This destination will directly support the following Key Strategic Orientations (KSOs), as outlined in the Strategic Plan:[3]

- 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, climate-neutral and resilient industrial value chains, circular economy and climate-neutral and human-centric digital systems and infrastructures, 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.

This Destination will contribute to putting the European Union and Associated Countries on track for achieving climate neutrality of the industrial sector by 2050, while also reducing other polluting emissions, and for speeding up Europe's independence from Russian fossil fuels, in line with the REPowerEU Plan, by means of cleaner, more efficient and more sustainable industrial processes.

The speed and scale of the twin green and digital transitions has accelerated, and significant opportunities lie ahead to position the European Union and Associated Countries as a technological and industrial leader of this transition, building on their world class R&I capacities and industrial base. Industrial ecosystems will not only need to develop, but also deploy technologies and reshape their goods and services towards a new reality, ensuring that industry can become the accelerator and enabler of the twin green and digital transition. It will also enhance the Union's open strategic autonomy with regard to the underlying technologies.

[3] Whilst Cluster 4 addresses KSOs A, C and D, in addition KSO B is becoming increasingly important, given the role of the industry highlighted in the zero-pollution action plan.

To achieve these goals, the activities in this Destination are complementary to those in Destination 'Increased Autonomy in Key Strategic Value Chains for Resilient Industry'.

The most relevant policies of the European Commission on this front are:

- The European Industrial Strategy of March 2020, and in particular the Update of May 2021: there is now a renewed momentum in the EU to tackle its strategic dependencies as well as to boost its resilience across key strategic areas. The Covid-19 crisis revealed the importance of improving production response and preparedness of EU industry, in support of its long-term competitiveness.

- The Digital Decade of March 2021, where the Commission presented a vision, targets and avenues for a successful digital transformation of Europe by 2030.

- The Circular Economy Action Plan of March 2020 announced initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and the resources used are kept in the EU economy for as long as possible.

- The Fit for 55 Package of July 2021, delivering the EU's 2030 Climate Target on the way to climate neutrality, given the process industries' 20% share of global greenhouse gas emissions.

- The Zero Pollution Action Plan of May 2021 addresses both pollution and waste, where research needs could be tackled and is particularly relevant to advanced materials and the process industries, as well as to the manufacturing industry.

The topics serving the objectives of this destination are structured as follows:

- **Manufacturing Industry**

The implementation of the Green Deal has major repercussions for manufacturing. Products and related value chains need to be made circular, carbon-neutral and regenerative – in other words, industry has to make positive contributions to the environment and to society, and offer a negative carbon footprint for future products. Manufacturing is expected to be a key driver in this transformation of industry. Current challenges addressed in this work programme include bio-intelligent manufacturing; high-precision and complex-product manufacturing; circularity and remanufacturing; collaborative distributed manufacturing and business models close to the customers, including Manufacturing as a Service, to enable the evolution from the 'smart factory' to the 'smart value network'.

This industrial revolution should not be to the detriment of workers. The lack of appropriate skills in manufacturing is becoming a concern in many sectors, opening the opportunity for the use of breakthrough innovative technologies to make manufacturing jobs more attractive; and more broadly to ensure that manufacturing provides prosperity beyond jobs, while respecting planetary boundaries.

- **A new way to build**, accelerating disruptive change in construction

The construction industry needs to improve its productivity and competitiveness, and upskill its workforce. Its transition pathway depends on greater digitalisation, resilience and resource efficiency across the board. This need has been heightened by recent rising demand following the pandemic, pressure to maintain and repair works and to address hazardous substances.

- **Energy efficient and climate neutral process industries**

From the R&I perspective, climate neutrality by 2050 should be the starting point for any action paving the way to a regenerative industrial transformation. The International Panel on Climate Change (IPCC) report on climate mitigation, released in April 2022,[4] points out that the goal of net-zero GHG emissions for industry is challenging but possible. It will need coordinated action throughout value chains to promote all mitigation options, including energy and materials efficiency, circular material flows, as well as abatement technologies and transformational changes in production processes.

In this context, the process industries' climate neutrality goal is strongly related to the objectives of becoming independent on fossil fuel and fossil fuel imports. To reach these objectives, production processes need to be energy efficient, implying advanced digitisation; renewable energies need to be integrated via electrifications or use of hydrogen; and abatement technologies including CCU for processes that are hard to decarbonise need to be further developed.

This Work Programme refers to the operational objectives of the Processes4Planet partnership, found in the respective Memorandum of Understanding.[5]

- **Circularity and Zero Pollution in process industries**

Energy-intensive industries need to embrace the circular economy and restorative feedback loops, not as an afterthought but as a key pillar of the design of entire value chains. In this context the Chemicals Strategy for Sustainability, which aims to better protect citizens and the environment whilst boosting the innovation for safe and sustainable chemicals, and its related Strategic Research and innovation agenda are also key. Energy-intensive industries need to commit to engage in Hubs for Circularity and to adopt new collaborative circular business models. There is also a clear space to increase the circularity of industrial wastewater, in symbiosis with urban wastewater, recycling a much higher share of the water, including from the municipal sector to industry and valorising more components in the wastewater.

The **Hubs for Circularity (H4C)** will be a key instrument to advance the research and innovation agenda of European industries towards the Green Deal's objectives. The H4Cs will implement a collection of industrial -urban symbiosis and circularity technologies at scale, which will lead to first-of-a-kind, lighthouse demonstrator plants of (near) commercial size

[4] IPCC report "Mitigation of Climate Change', April 2022

[5] http://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/c_2021_4113_f1_annex_en_v3_p1_1213806.pdf

implementing industrial symbiosis and/or urban industrial symbiosis. Starting from existing industry cluster or heavy industrialized urban areas, their aim 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 involving all stakeholders (Industry, SMEs, local authorities, educational institutions and civil society). It is a new way to re-imagine the whole value chain in a cross-sectorial and collaborative way exploiting synergies and anchoring in the local ecosystem to optimize the incoming resources including investments. It is about building on creativity, digital tools, AI, and breakthrough technologies for implementing cost-optimal pathways and new value chains for the engineering of a net-zero circular economy.

Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by demonstrating hubs for circularity (H4Cs) concepts[6], fostering circularity within and beyond process industries and driving the partnership's innovation portfolio towards "First of a kind" demonstrators to de-risk investment for subsequent roll-out. (P4Planet operational objectives 8 and 9).

- **Clean Steel**

Related to the objectives for energy-intensive industries in general, the steel industry will be enabled to reduce its GHG emissions to the Fit for 55 targets, in particular contributing to fulfilling the new obligations foreseen in the revised ETS Directive to prepare for transition to climate neutrality and to take new pathways towards Circular Economy concepts.

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 deployment 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 (Technology Readiness Levels), for example: matching value chains, enhancing product robustness; securing industrial integrators; and user acceptance.

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

[6] The website will be updated shortly with much more detailed info and examples https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-manufacturing_en#hubs-for-circularity-h4c

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.

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

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 industries; and **Processes4Planet** and **Clean Steel** for the energy-intensive industries. Wider activities include the further development of skills and competencies (also via the European Institute of Innovation and Technology, in particular EIT Manufacturing, EIT Digital and EIT Climate-KIC); and the use of financial products under the InvestEU Fund for further commercialisation of R&I outcomes. For the energy-intensive industries in particular, links with the Innovation Fund are important.

Synergies:

For advanced manufacturing in general, synergies are necessary between the Made in Europe Partnership and the Digital Europe Programme, primarily Industrial Data Spaces, Cybersecurity Centres and European Digital Innovation Hubs.

Related to the construction activities, Cluster 5 addresses the energy performance of buildings, under the destination ‘Efficient, sustainable and inclusive energy use’, as well as the Built4People co-programmed partnership for a ‘people-centric sustainable built environment’.

For the energy-intensive industries, there are synergies for energy efficiency and the management of thermal energy in industry in Cluster 5, under ‘Industries in energy transition’; and with the Clean Hydrogen partnership.

As some necessary activities of the energy-intensive industries, such as first-of-a-kind plants, involve deployment beyond TRL 7, synergies with other EU programmes are essential in this context, in particular with the Innovation Fund, with the Life Plus Programme, and with the activities of the EIB. International cooperation in process industries will be strengthened through Mission Innovation 2.0 ‘Net zero Industries’.

Innovation Actions — Legal entities established in China are not eligible to participate in Innovation Actions in any capacity. Please refer to the Annex B of the General Annexes of this Work Programme for further details.

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

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	
HORIZON-CL4-2023-TWIN-TRANSITION-01	334.27		20 Apr 2023
HORIZON-CL4-2023-TWIN-TRANSITION-01-TWO-STAGE	12.00		07 Mar 2023 (First Stage) 05 Oct 2023 (Second Stage)
HORIZON-CL4-2024-TWIN-TRANSITION-01		251.00	07 Feb 2024
HORIZON-CL4-2024-TWIN-TRANSITION-01-TWO-STAGE		37.00	07 Feb 2024 (First Stage) 24 Sep 2024 (Second Stage)
Overall indicative budget	346.27	288.00	

Call - TWIN GREEN AND DIGITAL TRANSITION 2023

HORIZON-CL4-2023-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)[7]

Topics	Type of Action	Budgets (EUR million) 2023	Expected EU contribution per project (EUR million)[8]	Indicative number of projects expected to be funded
Opening: 08 Dec 2022 Deadline(s): 20 Apr 2023				
HORIZON-CL4-2023-TWIN-TRANSITION-01-02	IA	48.00 [9]	5.00 to 6.00	8
HORIZON-CL4-2023-TWIN-TRANSITION-01-04	IA	37.60 [10]	5.00 to 7.00	6
HORIZON-CL4-2023-TWIN-TRANSITION-01-07	RIA	32.00 [11]	4.00 to 6.00	6
HORIZON-CL4-2023-TWIN-TRANSITION-01-08	CSA	1.00 [12]	Around 1.00	1
HORIZON-CL4-2023-TWIN-TRANSITION-01-31	RIA	32.00 [13]	8.00 to 10.00	3
HORIZON-CL4-2023-TWIN-TRANSITION-	IA	35.67 [14]	12.00 to	3

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

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

9 Of which EUR 21.37 million from the 'NGEU' Fund Source.

10 Of which EUR 17.00 million from the 'NGEU' Fund Source.

11 Of which EUR 14.90 million from the 'NGEU' Fund Source.

12 Of which EUR 0.40 million from the 'NGEU' Fund Source.

13 Of which EUR 14.90 million from the 'NGEU' Fund Source.

01-33			15.00	
HORIZON-CL4-2023-TWIN-TRANSITION-01-36	RIA	13.00 [15]	6.00 to 7.00	2
HORIZON-CL4-2023-TWIN-TRANSITION-01-37	IA	40.00 [16]	15.00 to 20.00	2
HORIZON-CL4-2023-TWIN-TRANSITION-01-40	RIA	30.00 [17]	10.00 to 12.00	3
HORIZON-CL4-2023-TWIN-TRANSITION-01-42	RIA	30.00 [18]	10.00 to 12.00	3
HORIZON-CL4-2023-TWIN-TRANSITION-01-43	IA	23.00 [19]	4.00 to 6.00	4
HORIZON-CL4-2023-TWIN-TRANSITION-01-45	RIA	12.00 [20]	3.00 to 6.00	2
Overall indicative budget		334.27		

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

14 Of which EUR 16.30 million from the 'NGEU' Fund Source.
15 Of which EUR 5.86 million from the 'NGEU' Fund Source.
16 Of which EUR 17.93 million from the 'NGEU' Fund Source.
17 Of which EUR 14.15 million from the 'NGEU' Fund Source.
18 Of which EUR 14.15 million from the 'NGEU' Fund Source.
19 Of which EUR 10.50 million from the 'NGEU' Fund Source.
20 Of which EUR 5.60 million from the 'NGEU' Fund Source.

Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Manufacturing Industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2023-TWIN-TRANSITION-01-02: High-precision OR complex product manufacturing – potentially including the use of photonics (Made in Europe and Photonics Partnerships) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 48.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering all three technology areas in the scope below, grants will be awarded to applications not only in order of ranking, but also to at least two projects in each technology area, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training

	Programme of the European Atomic Energy Community (2021-2025). [21]. The funding rate is up to 60% of the eligible costs as a way to increase the contribution of industry to this co-programmed partnership. This funding rate applies to both members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.
Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally extended by 3 pages.

Expected Outcome: Manufacturing industry will benefit from the following outcomes:

- High-precision manufacturing and/or manufacturing of products with complex geometries or structures; embedded electronics, optics or photonics; surfaces and surface functionalities; and multi-process manufacturing;
- Highly resilient and flexible production lines, enabling highly customised products across a wide range of markets, and ensuring open strategic autonomy for the manufacturing industry of the Union and Associated Countries.
- Significant reductions in the use of materials, waste, defects and energy consumption, which also lead indirectly to reductions in GHG emissions.
- Fostering the competitiveness of the European manufacturing industry, in general and (*only in the relevant projects*) in the field of laser machine tools and within the laser markets in particular.

Scope: Products are increasingly complex, e.g. in terms of geometries, structures, embedded and structural electronics, optics or photonics, micro-, nano- or bio-mimetic features or advanced and composite materials. Further constraints arise from new requirements of sustainability in production processes (resource and energy efficiency). In particular components and products have to be manufactured anticipating the fact that they would be disassembled, re-used re-manufactured or recycled.

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

Proposals should address the following:

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

- Advancement and demonstration of significant improvements in smart production technologies to **manufacture complex products** such as additive manufacturing, multi-process manufacturing, injection manufacturing, functional printing, intelligent and autonomous handling, shaping, joining, coating, and assembly technologies;

OR

- Advancement in **high-precision manufacturing technologies**, including for example mechanical machining, super-polishing, surface texturing, thin film coating, etching and electrochemical machining, handling and assembly processes, to achieve new product functionalities.

OR

- highly customised **laser-based production** including new and advanced methods, for example schemes of adapting laser beams and processes to provide a highly precise distribution of photons at the right place and at the right time.

Proposals should indicate which approach they are targeting.

Proposals may also propose to combine more than one of the above approaches when justified for specific high-tech product. For these cases, proposals should still indicate which of the approaches is the primary/main one.

Proposals are also allowed to combine two of the approaches above, *provided there is added value in such a combined approach. Arbitrary combinations without integration are excluded*.

In all cases, process development will be required to demonstrate and validate the benefits the technologies in flexible and individualised manufacturing processes, minimising waste, defects, energy consumption and emissions; and enabling sustainable, innovative and improved products. The quality of the new products should be validated according to the most advanced metrology capacities, and life cycle assessment should be considered.

The focus can be, for example, on addressing demands in healthcare, automotive, maritime and aviation industries, energy generation or environmental areas.

Proposals could additionally consider one or more of the following, *only provided this brings added value*:

- Use of novel sustainable and smart materials to achieve same or higher technical features in products while reducing environmental impact and waste;

- Parallel product and manufacturing engineering, developing cyber physical systems, e.g. digital twins, to manage complex production using data spaces across the whole value chain;

- Flexible and collaborative robots and multi-axis machines, to improve their accuracy to high-precision manufacturing;

- Multiscale physics-based models and machine learning/AI methodologies to improve prediction capacity/optimisation in manufacturing, remanufacturing and reuse;
- Management of data;
- Suitable, robust and traceable in-process process and dimension control

Links may be established with relevant cases emerging from the CSA project HORIZON-CL4-2023-RESILIENCE-01-39.

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. Where relevant, interoperability for data sharing should be addressed.

Interoperability for data sharing should be addressed, focusing on open and trustful federated concepts and standards, enabling effective cross-domain data communities, new data-driven markets, and the Digital Product Passport initiative.

Additionally, a strategy for skills development should be presented, associating social partners where 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 Partnerships Made in Europe and Photonics.

HORIZON-CL4-2023-TWIN-TRANSITION-01-04: Factory-level and value chain approaches for remanufacturing (Made in Europe Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 37.60 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning,

	navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally extended by 3 pages.

Expected Outcome: Manufacturing industry should benefit from the following outcomes:

- Suitably scaled green and digital technologies supporting remanufacturing, for circular value chains in industrial ecosystems;
- Remanufacturing of both components and products towards full circularity while retaining value or functions of components;
- Skills and education capabilities for remanufacturing.

Scope: Remanufacturing is an industrial process in which at least one change is made to waste products or components affecting their safety, performance, purpose or type. Remanufacturing aims to retain the usefulness of both products and components and is an essential step in achieving full industrial circularity without implying deterioration of the product.

This calls for both remanufacturing technologies at the factory level and their integration into circular value chains, including the streamlining data to support remanufacturing. Remanufacturing should not be focused only on the reuse of raw materials but should be aimed at reusing and upscaling components, valorising them and retaining or upgrading their functionality. Components, products and/or functions can be updated with new technology and improved beyond their initial functionality. Ultimately, remanufacturing is indirectly expected to reduce the level of resource consumption and hence also the level of CO_2-intensity of components.

Proposals should address technologies within specific industrial sectors or across industrial sectors:

- Develop cutting-edge remanufacturing approaches (design, technologies, business cases) and their integration into value chains;
- Demonstrate remanufacturing processes that retain components functionality in at least three user cases;

- The introduction of traceability aspects, quality control and a regulatory validation need to be considered;
- Repurposing of components into a variety of industrial sectors. Introduce flexible production concepts, advanced machinery, smart mechatronics, interactive and collaborative machines, robots and systems enabling efficient factory operation and reconfiguration;
- Consider operational and economic viability while also the environmental impact of the proposed approach.

A human-centric approach to remanufacturing should be integrated, with appropriate contributions from Social Sciences and Humanities (SSH); as part of this, a strategy for skills development should be included, associating social partners where relevant. This may include augmenting technologies and skills to strengthen the capabilities of the European workforce. Collaboration with EIT Manufacturing is encouraged, in particular on the development of skills.

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

Proposals should take the relevant EU-regulatory framework into account such as the Ecodesign Directive and the forthcoming Sustainable Product Framework (SPI)[22].

Proposals should take into account any relevant international standards (such as the Asset Administration Shell) and activities supported under the Digital Europe programme, e.g. in the area of Manufacturing Data Spaces and the Digital Product Passport initiative.

Research must build on existing standards or contribute to future standardisation. Interoperability for data sharing must be addressed, leveraging on existing ontologies and metadata and though the implementation of the FAIR data principles.[23]

Where relevant, proposals should contribute to standardisation of relevant technologies.

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

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

HORIZON-CL4-2023-TWIN-TRANSITION-01-07: Achieving resiliency in value networks through modelling and Manufacturing as a Service (Made in Europe Partnership) (RIA)

Specific conditions

[22] https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en
[23] Turning FAIR into reality: https://ec.europa.eu/info/sites/default/files/turning_fair_into_reality_1.pdf

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 32.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 3 and achieve TRL 6 by the end of the project – see General Annex B.
Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally extended by 3 pages.

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

- Availability of reliable models, simulators, digital twins, decision making and planning technologies for specific value networks, providing timely scoreboard views and enabling a better understanding of the impact of unforeseen events on manufacturing and industrial production.
- Availability of technologies to swiftly adapt logistics and production to varying external conditions, improving the resilience of the industrial systems and value chains, and the sustainability of the entire production process.
- Smart manufacturing networks that are resilient and capable of self-adaptation in response to external threats.

Scope: Manufacturing as a Service (MaaS) is a distributed system of production in which resources (including data and software) are offered as services, allowing manufacturers to access distributed providers to implement their manufacturing processes. This topic approaches MaaS from the value network perspective, aiming at exploiting the intrinsic flexibility and resilience provided by the possibility to use distributed and programmable resources on demand, under real-world conditions characterised by high volatility of the supply, the market requirements and the external constraints.

Proposals should develop:

- Realistic actionable models of value chains, which allow humans to react timely and better understand the impact of external events on the industrial system, and to propose simulations and scenarios that will appropriately respond to those events and optimise industrial production.

- Solutions that make use of the flexibility of the manufacturing ecosystem to respond to external events, enabling trusted cross organisation real-time data integration / exchange based on standards, and supporting the partial automation of the processes from the confirmation of the order up to the delivery of the product.

Models and simulations should be developed from a human-centred perspective, and lead to instructions for automated manufacturing and re-manufacturing facilities that can implement the retained scenarios and adapt production processes, stock levels and any other variables of the manufacturing and logistic flow, optimising production in terms of resilience, agility. The potential of a circular approach to address resilience should be considered.

Resiliency to failures should be taken into account, resulting in the capability to guarantee useful outputs and reliable production even under non-optimal conditions. Multidisciplinary research activities should address the way to develop robust models on the basis of uncertain and incomplete data, and to translate those models into practically usable digital twins, which can produce actionable information and instructions.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination, and demonstrate their results through at least two realistic use cases.

The results will contribute to making Manufacturing as a Service technically and economically viable, and are expected to improve to both the competitiveness of industry and the circularity and sustainability of the production/logistic processes. Proposals should explain how the proposed approach contributes to these objectives through measurable targets.

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

HORIZON-CL4-2023-TWIN-TRANSITION-01-08: Foresight and technology transfer for Manufacturing as a Service (Made in Europe Partnership) (CSA)

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

Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [24].

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

- Focused strategic foresight relevant to Manufacturing as a Service and digital technologies in manufacturing, namely (a) analysis of the best practices to advance circularity, decarbonisation, and sustainability of industrial production in the context of "Manufacturing as a Service" approach, (b) analysis of foreseeable developments and trends, including the potential advantages and disadvantages, regarding distributed Manufacturing as a Service vs. centralised manufacturing, (c) recommendations for an EU manufacturing standardisation strategy focusing specifically on the role of data and (d) roadmapping for EU industry to transform and anticipate these changes.
- Support for the transfer of information and technologies between Horizon Europe projects and other relevant initiatives, e.g., the Manufacturing Data Spaces and the network of European Digital Innovation Hubs.

Scope: Manufacturing as a Service (MaaS) is a distributed approach to production in which resources (including data and software) are offered as business-to-business services, allowing manufacturers to access distributed providers to implement their manufacturing processes.

Proposals should develop the strategic foresight listed under point 1 involving the manufacturing community at large, including the Manufacturing Data Spaces and the network of European Digital Innovation Hubs, as well as the Open Innovation Test Beds (OITBs).

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

Identification of strategies and best practices will take into account the evolving geopolitical context.

The activities will also include an effective dissemination campaign, the organisation of events and workshops to facilitate technology transfer and collaboration. A specific focus should be given to best practices to support circularity and sustainability in industrial production through digital technologies in a "Manufacturing as a Service" context.

Only one proposal will be selected for funding.

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

Energy Intensive Process Industries

Energy-efficient and climate neutral process industries
Proposals are invited against the following topic(s):

HORIZON-CL4-2023-TWIN-TRANSITION-01-31: Energy efficiency breakthroughs in the process industries (Processes4Planet partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 32.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [25].

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

Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally extended by 3 pages.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by designing and digitising industrial processes for a maximum energy efficiency, ensuring process flexibility and capturing the full potential of renewable energy (related to P4Planet operational objectives 1 and 5).

Projects are expected to contribute to the following outcomes:

- Increase the energy efficiency of energy intensive industrial processes by reducing energy use by at least 30% and the process as compared to current state of the art;
- Enable the techno-economic feasibility of novel technologies and processes, validated and demonstrated at suitable scale against state of the art of industrial processes;
- Enable the potential of an increased use of renewable energy;
- Contribute to achieving EU climate neutrality goal and becoming independent from fossil fuel and fossil fuel imports as put forward in the REPowerEU Plan[26].

Scope: To decarbonise the energy-intensive industries both, the availability of affordable renewable energy, and the increase of the industrial processes energy efficiency, will be needed. Today‘s energy efficiency improvements in conventional plants are about 1-2% annually. The use of digital technologies in process optimisation has the potential to further reduce this energy demand. However, digital technologies alone cannot achieve the required change in the process industries’ energy efficiency, the combination of digital technologies with highly energy efficient process breakthroughs is required.

Proposals under this topic should:

- Focus on the development of highly efficient technological breakthroughs for the innovation of the most energy intensive parts of specific processes;
- Demonstrate the decrease in energy intensity of output level (intermediate, final product);
- Integrate novel digital technologies from the fields of distributed process control and data driven AI based optimisation;
- Demonstrate and evaluate energy efficiency gains, where relevant in optimal interaction with energy flexibility and integration of renewables.

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

[26] COM/2022/230 final

The proposals should include energy efficiency, techno-economic and life-cycle assessments considering the overall process.

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

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. Proposals are encouraged to consider outcomes from the projects carried out in the call DT-SPIRE-06-2019: Digital technologies for improved performance in cognitive production plants.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-33: Electrification of high temperature heating systems (Processes4Planet Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 12.00 and 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 35.67 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs as a way to increase the contribution of industry to this co-programmed partnership. This funding rate applies to both members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Projects outcomes will enable achieving the objectives of the Processes4Planet partnership, and the transition of the process industry towards climate neutrality, by developing new electrified processes, ensuring process flexibility, and capturing the full potential of renewable energy (related to P4Planet operational objective 1).

Projects are expected to contribute to the following outcomes:

- Demonstrate the use of advanced electric heating technologies for high temperature demand systems in the process industry;

- Prove the effectiveness of the technologies towards GHG emission avoidance;
- Reduce process emissions of high temperature heating systems by at least 30% compared to current state of the art levels of the process with fossil-based heating system;
- Enable the integration of renewable electricity in the process industries to substitute fossil fuels for heating, thereby contributing to the independence from fossil fuel and fossil fuel imports as put forward in the REPowerEU Plan[27];
- Showcase the scalability and the cost efficiency of the proposed solutions;
- Enable the economic viability of the entire unit to compete with the existing state of the art of fossil-based heating systems and increase of the competitiveness and resilience of the European process industry.

Scope: High temperature (over 400 °C) industrial heating systems, powered by fossil fuel combustion, are responsible for 20% of process industries GHG emissions. The topic focuses on the sustainable electrification of high temperature heating systems, for example, industrial furnaces, kilns and crackers among others. Electrification of these heating systems with renewable electricity could represent a major reduction of the related GHG emissions.

The proposals should:

- Integrate existing highly efficient technologies, e.g., induction heating, hybrid operation between electric heating and zero-carbon fuel heating microwave and plasma technologies, electric resistances, and/or the combination with digital technologies or hybrid modelling; this may include the development of high temperature heat storage for flexible usage of electricity (load shifting) or renewable electricity production (production fluctuation);
- Take a holistic approach which may include aspects such as advanced materials requirements and appropriate equipment design;
- Improve the process safety, flexibility, and ease of process control;
- Showcase the improved performance through at least one realistic use case that can be replicable in more than one process industry sector with demonstrable economic return.

The inclusion of a GHG avoidance methodology[28] is recommended and should provide detailed descriptions of baselines and projected emissions reduction.

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

[27] COM/2022/230 final

[28] That could follow Innovation Fund methodology: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan and financial model) indicating the possible funding sources to be potentially used (e.g., Innovation Fund, InvestEU, ESIF). Societal and environmental impact and implications for the workplace (such as skills, organisational change) should be outlined.

Research must build on existing standards or contribute to standardisation. Where relevant, interoperability for data sharing should be addressed.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programs and platforms and are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-36: Modelling industry transition to climate neutrality, sustainability and circularity (Processes4Planet partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 13.00 million.
Type of Action	Research and Innovation Actions
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [29].

Expected Outcome: Processes4Planet's Horizon Europe public private partnership ambition is to achieve a profound change in the way the materials that citizens need to sustain their quality of life are produced. Processes4Planet is about transforming European process industries to make them circular and achieve overall climate neutrality at EU level by 2050,

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

while enhancing their global competitiveness. Modelling capacity and scenarios are needed to chart the pathways towards climate neutrality. Projects outcomes will enable the achievement of the objectives of Processes4Planet partnership by contributing to new framework conditions to generate a market for climate neutral and circular solutions (related P4Planet operational objective 10). They will support EU climate ambitions and, following the International Panel on Climate Change (IPCC) report on climate mitigation recommendations,[30] allow for actions throughout value chains to promote all mitigation options, including energy and materials efficiency, circular material flows, as well as abatement technologies and transformational changes in production processes.

Projects are expected to contribute to the following outcomes:

- Development of a model, enhancement of existing modelling tools [31] towards understanding the pathways for industry, and Energy Intensive Industries in particular, to contribute to EU's climate neutrality;

- Modelling of scenarios of possible pathways of how industry, and Energy Intensive Industries in particular, can become climate neutral according to the following five dimensions: (1) their energy demand and use and energy efficiency, (2) their emissions including process emissions; (3) in use of raw materials, chemicals and water (e.g. via increasing the use of circular approaches and material substitution, also in view of ensuring affordability of industrial products); (4) their production of consumer goods/equipment/construction products (e.g. looking at sustainability of products and embedded carbon – a preliminary approach only); (5) possibility of replacing fossil carbon in materials by more sustainable streams (e.g. recycled carbon from industrial emissions, from waste, sourced from sustainable biomass or directly from the atmosphere[32]);

- Facilitate future EU and national industry, climate and energy policy assessments. Climate neutrality of industry will be a strong priority for the EU and national policies by 2030 and towards 2050 as industry is considered as hard-to-abate sector[33]. Any policy initiatives on the EU or national level will require a robust, forward-looking analytical basis interlinked with macro-economic and energy system trends and such can be provided by modelling;

- Set the climate neutrality transition pathways for process industries in an open and transparent manner via design, modelling, and assessment of pathways for these industries. Modelling exercises can set the framework conditions and project market uptake of transformative solutions and products;

30 IPCC report on "Mitigation of Climate Change', April 2022

31 Building on previous and ongoing related projects either from specific sectors or across different sectors notably as discussed at Energy Modelling Platform for the EU: https://www.energymodellingplatform.eu/

32 Sustainable Carbon Cycles Communication (COM (2021) 800 final

33 compared to buildings sector or power generation

- Enhance the knowledge about climate neutrality pathways for industry and academia as the resulting modelling capacity (model code) and input data should be fully transparent and published under an open-source licencing.

Scope:

Development of the model

Currently the modelling tools to represent EU industry's pathways to climate neutrality are not fully developed. The new modelling capacity should cover historical development starting in1990 and projections up to 2070 and this for the European Union and Associated Countries altogether and each Member State/country separately as well as for European Economic Area according to the five dimensions outlined in the expected outcomes. Considering that materials, chemicals and goods are sourced and traded globally, or at least regionally, global sourcing and trade has to be captured with relevant granularity and based on exogenous assumptions and/or links with global trade models;. Considering that these industries link with other sectors of the economy, innovative ways have to be found to integrate such capacity in a fully consistent energy system picture and to link it with broader macro-economic developments (notably as far as demand for industrial products is concerned) and meta-trends such as digitalisation.

The proposals should be built in a modular manner and progressively lead to the development of an integrated modelling capacity allowing to capture the economics and behavioural aspects of demand, production and trade of materials, as well as techno-economic trajectories of the industrial sectors identified above. That would include (but not necessarily limited to) concepts from system dynamics modelling (for materials flows and stocks), techno-economic modelling (for the economics of production costs, elasticity of demand or trade effects), macro-economic modelling (socio-economics impacts), as well as agent-based modelling (choices of materials or technologies). The proposal should produce first results available for review by the project midterm.

The proposals as a part of its validation and stakeholders' involvement will enable to participate in peer-review processes, scientific conferences and publish in scientific journals and create possibilities for a feedback loop from stakeholders. The modelling capacity should be continuously developed based on the feedback from stakeholders.

Modelling of scenarios

Secondly, the proposals should deploy this new modelling capacity to explore, through the development of several "what if" scenarios, capturing all dimensions mapped above in a consistent way. The scenarios produced with the model should be contrasted but internally consistent in their policy and economic contexts, presenting different pathways for climate neutrality transition in terms of energy needs, addressing the process emissions as well needs and supply of material and technological options to produce the materials in needed quantities. In addition, a preliminary approach for tracing the carbon embedded in products and replacing fossil carbon in materials should be explored.

Proposals should seek cooperation and give input to the Processes4Planet partnership Advisory Committee panels,[34] i.e., "Impact Panel" and as social innovation is concerned, the "Feedback Panel".

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and comparative tools e.g., the Energy and Industry Geography Lab of the Joint Research Centre.

Cooperation with other selected projects under this topic is strongly encouraged.

This topic implements the co-programmed European partnership Processes4Planet.

Circularity and Zero Pollution in process industries
Proposals are invited against the following topic(s):

HORIZON-CL4-2023-TWIN-TRANSITION-01-37: Hubs for circularity for near zero emissions regions applying industrial symbiosis and cooperative approach to heavy industrialized clusters and surrounding ecosystems (Processes4Planet partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 15.00 and 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.
Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally

[34] Memorandum of Understanding for the Co-programmed European Partnership Processes4Planet (P4Planet), 3. Governance. http://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/c_2021_4113_f1_annex_en_v3_p1_1213806.pdf

	extended by 3 pages.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by demonstrating hubs for circularity (H4Cs) concepts, fostering circularity within and beyond process industries and driving the partnership's innovation portfolio towards "First of a kind" demonstrators so as to de-risk investment for subsequent roll-out. (P4Planet operational objectives 8 and 9).

Projects are expected to contribute to the following outcomes:

- Achieve a step change in circular utilization of resources within the process industries reducing the use of virgin resources (materials, energy, and water) by at least 20% of reduction as compared to current state of the art;
- Citizens living in proximity of heavily industrialized clusters will benefit from a healthier environment through industrial symbiosis by lowering emissions through circular and renewable energy sources;
- Use industrial symbiosis and cross-sectorial cooperation to pave the way for achieving the EU Green Deal and "Fit for 55" package objectives: providing recommendations for optimized regional framework conditions by highlighting barriers and suitable innovation-oriented policies.

The targets above are meant to be achieved collectively by the region/area where the demonstration is located, not only by consortium members.

Scope: An industrial symbiosis, near commercial scale demonstrator, hub should integrate infrastructures (e.g., industrial waste, by-product and water management infrastructure, fluid flow networks, digital infrastructure), and energy networks and grids (e.g., smart operations scheduling, district heat integration, digital power plant including distributed generation, seasonal storage, biomass, and heat pumps integration). Industries involved should boost: their resource efficiency, heat recovery, integration of e renewable energies, use of hydrogen as an energy carrier, and/or support the implementation of CCU locally or prepare for CCS logistics. The proposed demonstrator should comprehensively show how symbiosis and cross-sectorial cooperation can trigger the green transition by sharing resources and infrastructure investments.

Proposals should address the following aspects:

- Develop systemic solutions leading to a Hub for Circularity (H4C) for near zero emissions as described above;
- (Co-)design and adapt existing processes to integrate new solutions (energy and mass flow coupling, infrastructure, and logistics) and to exploit new synergies between sectors;

- Use digital modelling tools and sensing systems as a basis for dynamic resource management, including information on quantities and characterisation of material, component and product streams in view of full integrated LCA;

- Establish IT infrastructures and tools that provide a secure basis for the integrated management and the preservation of confidentiality of sensitive data, it might not be in the same location as the demonstrator and serve the needs of multiple hubs;

- Deploy one Industrial symbiosis near commercial scale demonstrator using renewables as energy sources, including renewable hydrogen as energy carrier, to achieve at least 30% CO2 reduction when deployed at full scale at the Hub for Circularity and close environment level. This should balance the overall energy consumption with efficiency gains for the Hub for Circularity of at least 10%, including utilisation through cascading heat recovery, smart grid, and digitalised power plants. Optional: in addition, apply or enlarge the use of CCUS (Carbon Capture Utilization and Storage) to the existing local industries; the sustainability gains in energy use should be detailed;

- Plan in detail the replication and adaption of the concept, including the simulation and the business case and exploitation strategy of the First of a Kind hubs, in two to three alternative locations in close cooperation with the relevant local actors;

- Consider when applicable the co-development of industrial decarbonization strategies with heat-nets, i.e., based on a socio-economic optimum in the cascading re-use of waste heat and the supply low temperature process heat to the surrounding ecosystem;

- Use established reporting methodologies for the assessment of industrial symbiosis activities and exchanges including Symbiosis Readiness Levels (SRLs) and best practices established by the H4C European Community of Practice (ECoP). In addition, interact with the ECoP for support, best practice and knowledge exchange on technological and non-technological issue;

- Include a plan to extend the hub to additional parties who also should benefit and multiply the local/regional synergies in the co-implementation of the identified innovations and solutions within the next five years;

- Implement a social innovation action involving at least one of the local community actors and, additional actions to facilitate relations and engage with e local community actors e.g., exchanging knowledge with the educational establishments and developing flexible learning resources.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. As a project output a more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan and financial model) indicating the possible funding sources to be potentially used (e.g. Innovation Fund, LIFE, InvestEU, ESIF).

Relevant indicators and metrics, with baseline values, should be stated clearly in the proposal. Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Clustering and cooperation with other selected projects under this cross-cutting topic and other relevant topics in Horizon Europe as well as building on existing projects is strongly encouraged (see also Industrial Symbiosis[35] and Trends[36] Report from March 2020).

This topic aims to support the goals of the smart cities and climate adaptation missions by contributing to a decrease of harmful industrial emissions while favouring renewable energy sources.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-40: Sustainable and efficient industrial water consumption: through energy and solute recovery (Processes4Planet partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achieving the objectives of Processes4Planet partnership by designing industrial processes for the maximum resource (water) efficiency and developing new process to ensure full valorisation of process industries wastewater, recycled water, energy, and solute recovery (P4Planet operational objectives 5 and 7).

[35] https://op.europa.eu/en/publication-detail/-/publication/f26dfd11-6288-11ea-b735-01aa75ed71a1
[36] https://www.aspire2050.eu/sites/default/files/pressoffice/publication/trends_report_2020.pdf

Projects are expected to contribute to the following outcomes:

- Demonstrate sustainable industrial water consumption based on new technologies for energy and solute recovery;
- Enable full circular use of water in process industry thus reducing industry dependence and utilisation of fresh water;
- Enable the techno-economic feasibility of the processes and technologies for water treatment and recycling particularly when combined with energy and waste reduction strategies to compete with the existing state of the art;
- Maximise the recovery of substances and energy present in the wastewater streams;
- Demonstrate contribution to EU climate neutrality goal.

Scope: Wastewater discharge from industry has decreased over decades. This is a consequence of increased regulation (e.g., Industrial Emissions Directive, IED; the European Pollutant Release and Transfer Register, E-PRTR), improvements in treatment and the implementation of best available techniques. Amongst process industries, pulp and paper, steel and chemicals have high wastewater discharges. The Processes4Planet target is to demonstrate the potential for 90% of wastewater reuse by 2030. A breakthrough in wastewater reduction could be envisaged, by combining existing technologies and novel water treatment technologies and reuse with process intensification, energy recovery and excess heat use e.g., integrated processes with separation systems will reduce water and energy consumption and the amount of final industrial wastewater produced. In addition, industrial waste waters often contain significant amounts of valuable solutes (e.g., organic matter, salts, phosphates, etc.) which are not optimally valorised.

The proposals should:

- Combine existing and novel water treatment technologies and re-use with process intensification;
- Use in combination smart monitoring technologies including affordable long lasting and reliable sensors and AI driven devices, integrated system risk management models and decision support tools and technologies for water re-use in process industries;
- Seek to integrate advanced digital tools for the optimisation of their process, such as Digital twins;
- Propose new technologies for recovering valuable solutes present in wastewater (metals, organic compounds, etc.) and for eliminating hazardous substances (e.g., micro and nano particles, toxic substances).

The proposals should include energy efficiency, techno-economic and life-cycle assessments considering the overall process. In order to maximize impact, technologies in the proposals should not be focused on one sector, but the proposed solution should be applicable in

different types of industries; elements related to the replicability and scalability of the technology should be provided. Proposals are encouraged to consider outcomes from the Horizon 2020 topic CE-SPIRE-07-2020: Preserving fresh water: recycling industrial waters industry.

In addition, the topic could explore synergies with the Ocean and Waters and the Soil missions.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms. Proposals are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

International cooperation can be considered specially with countries advanced in the field that could bring mutual benefit from different perspectives.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2023-TWIN-TRANSITION-01-42: Circular economy in process industries: Upcycling large volumes of secondary resources (Processes4Planet partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the

	Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [37].
Exceptional page limits to proposals/applications	In order to include a business case and exploitation strategy, the page limit in part B of the General Annexes is exceptionally extended by 3 pages.

Expected Outcome: Projects outcomes will enable the achievement of the operational objectives of Processes4Planet partnership by developing new processes for circularity of secondary materials from wastes/residues for all industrial processes (related to P4Planet operational objective 6).

Projects are expected to contribute to the following outcomes:

- Prove the technical and economic feasibility of the use of secondary resources in the process industry leading to products with identical properties and performances as those produced using primary resources and allowing production without quality restriction;
- Increase the use of secondary resources in the process industry leading to significant increase in resource efficiency across the value chain and subsequent reduction of CO2 emissions; reduction of waste sent to landfill and overall positive environmental impact;
- Increase the competitiveness of the European process industry; new business opportunities and revenue flows for recycling companies, benefiting particularly SMEs, which dominate this sector of the market;
- The proposed technologies should contribute to the matching of supply-versus-demand of feedstock at the level of quality constraints (removal of impurities or wrong matrices, concentration etc.);
- Foster data sharing, and FAIR (Findability, Accessibility, Interoperability and Reusability) digital assets principles, considering the application of digital product passport between recycling companies and the process industry to improve the economy of scale in upcycling of material streams;
- Increase the use of unused and new skills to unfold the potential of the technological solutions at the workplace for upcycling and contribution to inclusive growth;
- At a longer term, to pave the way toward sustainable-by-design for circular products.

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

Scope: Currently only 12% of the material resources used in the European process industry are recycled and recovered materials and these are mostly down cycled to less valuable products. To move towards a truly circular and sustainable process industry that uses its resources consciously, and without landfilling, breakthrough innovations aiming at upcycling large amounts of secondary resources are needed. The focus of this topic is the upcycling of secondary resources that must lead to the same quality and diversity of products as those obtained when using primary resources. The innovation needed will depend on the addressed waste category. However, even if the upcycling technologies may be sector specific, the cross-sectorial elements are important and should deserve due attention.

Proposals are expected to address the following aspects:

- Considering the upgrading of secondary resources, when relevant, which may include the development of better separation and sorting technologies and digitalisation;
- Ensure consistent quality and safety of recyclates and their suitability for the upcycling process itself;
- If relevant, detection and removal additives in the secondary resources stream;
- Take due account of logistic aspects such as production planning, risk assessment and management or zero defect at supply chain level;
- The innovative upcycling of the secondary raw materials should be demonstrated through at least two realistic use cases that must lead to the same quality and diversity of products as those obtained when using primary resources, with demonstrable economic return, developed in closed cooperation between recyclers, process industry, users and technology providers;
- Successful upcycling relies on advanced monitoring and sensing in the process industries and value chains, and on an improved data completeness, accuracy and interoperability between the process and the recycling companies. Upcycling may create new business opportunities and models. These are aspects that should be duly considered.

Proposals should include energy efficiency techno-economic and life-cycle assessment considerations of the overall process.

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

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

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

Additionally, a strategy for skills development should be presented, associating social partners where relevant. Particular attention should be given to the cooperation with existing initiatives that have developed education and skills activities and outcomes in this area.

All proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national, or regional initiatives, funding programmes and are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

International cooperation can be considered specially with countries advanced in the field that could bring mutual benefit from different perspectives.

The proposals under this topic may cover any of the process industries sectors and related end of life wastes sectors (plastic wastes and composites,[38] which were the subject of the WP 2021-22,[39] and steel scrap implemented as part of the Clean Steel partnership are excluded).

This topic implements the co-programmed European partnership Processes4Planet.

Clean Steel
Proposals are invited against the following topic(s):

HORIZON-CL4-2023-TWIN-TRANSITION-01-43: Low carbon-dioxide emission technologies for melting iron-bearing feed materials OR smart carbon usage and improved energy & resource efficiency via process integration (Clean Steel Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 23.00 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 6-7 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following

[38] The following are not composites and therefore are within the scope of this topic: Main materials in recyclates that are contaminated by minor components as heritage from former uses in composites (e.g. other polymers, resins, …), plastics (e.g. additives), construction materials (e.g. minerals with organics or metals), etc. whereas the contamination hinders the full qualitative recycling of the main material.

[39] HORIZON-CL4-2021-TWIN-TRANSITION-01-17: Plastic waste as a circular carbon feedstock for industry (Processes4Planet Partnership) (IA); HORIZON-CL4-2021-RESILIENCE-01-01: Ensuring circularity of composite materials (Processes4Planet Partnership) (RIA)

	exceptions apply: To ensure a balanced portfolio covering the two technology areas in the scope below, grants will be awarded to applications not only in order of ranking, but also to at least one project in each technology area, provided that the applications attain all thresholds.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs as a way to increase the contribution of industry to this co-programmed partnership. This funding rate applies to both members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Projects outcomes will enable achieving the objectives of the Clean Steel Partnership (CSP) by contributing to one of the following two aspects:

1. Integrating the next-generation iron-bearing feed materials melting technologies into an existing and optimised steelwork, to further push the transformation towards a low-CO_2 production site (related to the CSP Building Block (BB) 3: Melting of pre-reduced and reduced ore, scrap, and iron-rich low-value residues for clean steel production[40]);

2. Curtailing CO_2 emissions generated by the steel industry by smart carbon usage - process integration (SCU-PI), which allows reducing fossil fuel (e.g., coal) used in blast furnace - basic oxygen furnace (BF-BOF), electric arc furnace (EAF) and direct reduction - EAF (DR-EAF); this includes, among others, the (partial) replacement of coal by e.g. biogas, or hydrogen, or the advanced management of the energy streams and process gases (e.g., off gases released from EAF / BF-BOF; relevant relations to the CSP BB 1 “Gas injection technologies for clean steel production”; BB 4 “Adjustment of today’s production to prepare for the transition towards climate neutrality”; BB 7 “Heat generation for clean steel processes”, and BB 10 “Enablers e.g., skills, digitisation, for clean steel development”).

Projects related to the above point 1 are expected to contribute to one or more of the following outcomes:

- Innovative or improved melting processes for next-generation clean steel production, such as, but not limited to, charging and pre-heating technologies for iron-bearing feedstock to reduce the CO_2 emission by at least 20 % compared to current state of the art;

- Integration of next generation melting technologies into an existing and optimised steelwork, with the objective to enable transformation towards a low-CO_2 production

[40] https://www.estep.eu/assets/CleanSteelMembersection/CSP-SRIA-Oct2021-clean.pdf

site. Proposed solutions should consider also the supply chain to strongly reduce the environmental footprint of the steel melting process;

- Enhance the use of iron-bearing feedstock intermediate products with variable content of carbon and variable metallisation, including low-value iron-based sources. (e.g., DRI, recovered by-products) in melting processes.

OR

Projects related to the above point 2 are expected to contribute to one or more of the following outcomes:

- Use advanced information and communication technology (ICT) to achieve process and energy integration and optimisation of the efficiency of steelmaking and downstream processing (heating and treatment furnaces) in steel plants;
- Improve the injection of metallurgical gases, as well as hydrogen-rich gases (e.g., a mixture of hydrogen and methane) and/or hydrogen, within the steel making processes;
- Adaptation of gas handling systems to new gases and their related properties;
- Utilisation and recycling of gases (e.g., carbon-containing process gases, oxygen, external gases, such as but not limited to, waste gases from a neighbouring chemical plant or syngas produced from an external pyrolysis plant) in integrated plants with mixed technology routes;
- Enhance production and energy management of integrated plants with mixed technology routes (e.g. blast furnace–basic oxygen furnace (BF-BOF), direct reduction-electric arc furnace (DR-EAF)), to drastically reduce the consumption of coal and the CO_2 emissions.

Scope: Proposals should aim at one of the following two aspects, corresponding respectively to the points 1) and 2) outlined under the expected outcomes section:

1. Proposals should address novel and adapted low-CO_2 emission technologies for pre-treatment, pre-heating, and melting of iron-bearing feedstock materials with variable content of carbon and variable metallisation including, among others, low-value iron-based sources (i.e., >5% of acidic gangue), or dust and sludge from de-dusting systems. The focus is on the three technological routes of blast furnace–basic oxygen furnace (BF-BOF), electric arc furnace (EAF), and direct reduced iron / hot briquetted iron form (DRI / HBI) including the refining and casting processes.

Multidisciplinary research activities should address one or more of the following:

- Adding variable percentages of steel scrap and/or a wide range of iron-bearing feed materials with variable content of carbon and variable metallisation to the melting process, including low-value iron-based sources (i.e., >5% of acidic gangue and/or residue) without prejudice to the yield of the metallic charge;

- Adaptations on existing melting processes to replace the traditional use of carbon and hydrocarbons (e.g., for re-carburisation of the liquid, for promoting slag foaming or charge heating) with climate-neutral sources and/or hydrogen;

- Reduction of the specific consumption of the melting step to achieve a low carbon process by optimisation of energy inputs (electrical vs. chemical) depending on the charge mix (scrap, DRI, HBI, pig iron, low-value iron-based sources) and/or by pre-heating of the iron-bearing feed materials;

- Handle a variability of iron-bearing feedstock in the melting process by methods to assess the material quality within production chains, to recover metal contents from low-value iron-ore feedstock or residues by pre-reduction or reduction smelting with H_2, biogas, CO_2-lean electricity, and carbon-bearing residues;

- Controlling of tramp elements in molten liquid obtained by low iron-bearing feedstock to ensure quality and castability of melted steel and improvement of yield and quality of process and product;

- New sensors and tools for real-time management inside the melting process such as liquid metal and slag temperature and composition and/or reliable energy forecasting to optimal setup and process control.

OR

1. Proposals should aim at the reduction of fossil fuel and reductant used in both BF-BOF and EAF / DR-EAF steel production and, in turn, curtailing CO_2 emissions, using process technologies for gas injection e.g., for BFs, DR plants, but also for EAFs. New control techniques will also have to be developed considering process needs, safety issues, and economic aspects. Gas injection options have the potential for very low CO_2 emissions but need intermediate steps before being ready for full industrial deployment (e.g., injection of high percentages of hydrogen in BF and EAF). To achieve the objectives, it could be relevant to consider technology improvement along with developing appropriate business models.

Multidisciplinary research activities should address one or more of the following:

- Process integration through injection of metallurgical gases or biogas or O_2 and H_2 (H_2-rich gases or pure H_2) into metallurgical reactors (e.g. BF, DR, or EAF) to minimise the need for fossil carbon, including new developments regarding the related process technology and control technology;

- Utilisation and recycling of gases as substitutes in existing steel processes such as, but not limited to, coking plant, sinter plant, BF, DR, BOF, EAF;

- Consider techniques and tools, which support the immediate decrease of the carbon footprint on the industrial level, with measures such as, but not limited to, involve the production cycle, the energy, and materials supplied;

- Adapt gas handling and distribution to new gas properties and amounts and consider process needs, safety issues, and economic aspects;
- Integrate new measuring technologies and/or digital tools for monitoring and control inside the novel architectures of ICT covering the processes considered (existing and new processes), conditions and resources; the extensive use of Industrial Internet of Things (IoT) approaches should allow the easy and fast integration of the new measurement techniques into the set of data streams to be monitored and offline / online used for process setup and control and knowledge extraction;
- Provide concepts addressing the re-optimisation of the process integration in future integrated steelworks based on clean steel production technologies and considering the stepwise transition of production lines from current conventional iron and steelmaking to future low carbon technologies including relevant intermediate states with mixed production chains.

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

HORIZON-CL4-2023-TWIN-TRANSITION-01-45: Circular economy solutions for the valorisation of low-quality scrap streams, materials recirculation with high recycling rate, and residue valorisation for long term goal towards zero waste (Clean Steel Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 5-6 by the end of the project – see General Annex B.

Expected Outcome: Projects are expected to contribute to one or more of the following outcomes:

- Implementation of highly efficient technologies for recovering metal (iron and non-ferrous metals) and mineral fractions from in-plant steelmaking residues. The recovery technology should condition the composition and properties of the residue such as, but not limited to, slag, sludge, scale, filter dust, sinter waste produced by blast furnace / basic oxygen furnace (BF / BOF) and electric arc furnace (EAF) routes, but also by next-generation iron and steelmaking such as, but not limited to, the direct reduction / electric arc furnace (DR / EAF) pathway including the melting and reduction of low-grade iron ore. Two possible ways are envisioned: the first one is based on cooling and mechanical steps, such as, but not limited to, wet or dry granulation followed by phase separation; the second one relies on dedicated processes to enable a direct recycling of residues in existing production processes or in standalone pyro-metallurgic melting and reduction or hydrometallurgical / biohydrometallurgical units. Such knowledge and results should support the valorisation of residues in the present value chain and/or in innovative applications. If appropriate, residues could be chemically and structurally characterised at micro-scale level via characterisation (also multi-modal) performed at analytical research infrastructures, which would allow obtaining relevant statistical information;

- Describe and/or modify the composition and properties of residues such as, but not limited to, slags and/or sludge produced by next-generation steelmaking such as, but not limited to the DR / EAF pathway. Such knowledge and results should support the valorisation of the residues in the present value chain and/or in innovative applications. If appropriate, residues could be chemically and structurally characterised at micro-scale level via characterisation (also multi-modal) performed at analytical research infrastructures, which would allow obtaining relevant statistical information;

- Enhanced utilisation of low-quality scrap by new technologies and by new iron/steel making routes (such as smart BF-BOF routes to be line with decarbonisation targets), targeting high quality of the finished product and reduced CO_2 emissions. The aim is to remove scrap impurities (tramp elements) such as, but not limited to, copper before melting, for example through scrap yard management and charge preparation for quality upgrading, or after the melting in liquid phase, through, but not limited to, metallurgical methods;

- Technologies to broaden the types of ore grades utilized in different processes. The aim is to establish processes that allow for upgrade of low-grade iron ores and other iron-bearing materials to make them suitable for, but not limited to, cold bonded agglomeration, pelletisation, or direct use in existing steelworks.

Scope: In the medium-term scenario, new technologies will enter in the iron and steelmaking production process, e.g., higher amount of scrap in basic oxygen furnaces (BOF), more electric arc furnace (EAF) based steelmaking, as well as more directly reduced production capacity are foreseen. Therefore, it is necessary to consider the influence of the feedstock quality, of the new production technologies and of the composition of the by-products generated on the present model of circular economy for both, economic, and environmental aspects.

Recycling of steel scrap (no matter if it is home-scrap, industrial scrap, or post-consumer scrap), the increased consumption of scrap, the recovery of iron from residues and the use of low-quality iron ore materials are vital to diminish the need for additional primary resource extraction and hence to decrease the environmental impact of steel manufacturing. This is also contributing to a wise and sustainable management approach of iron resources. Applying circular economic principles to product design (thus, designing for remanufacture and recycling) will allow ferrous and non-ferrous metals, such as copper, to be more easily separated and recycled.

Proposals should consider higher utilisation of low-quality iron-bearing materials, in particular, but not limited to, low-quality scrap with higher amounts of unwanted elements (residual and alloying elements, such as Cu, Sn, Sb, As and Bi, but also Cr, Mo, B) that prevent the production of many steel grades and a higher utilisation of internal residues; all focused on the recycling of its metal contents. Where appropriate for the study proposed, analytical research infrastructures, such as synchrotron facilities, should be considered as capable of providing large amount of statistically relevant data. The aim is to obtain a sustainable vision of reduced virgin raw materials use.

Moreover, the existing recycling and reuse solutions for today's steel industry will be affected and new solutions need to be developed to maintain a sustainable development of the steel industry in the future. Projects should aim at the selection and integration of best available and applicable technologies supported by digital smart tools. These are key elements to improve and adapt circular economy solutions for the long-term goal towards zero waste increasing the use of scrap, the materials recycling rate and the residue valorisation by targeting to achieve the same quality of the finished product and at the same time reducing CO_2 emissions due to lower energy need with respect to iron-ore.

Multidisciplinary research activities should address one or more of the following:

- New technologies for reduce / reuse / recycle of residues and by-products in the next generation iron ore and steelmaking process:
    - Increasing reuse and recycling of steelmaking and foundry slags;
    - Recycling and valorisation of dusts, and sludges;
    - Recovering iron and metal-fractions from in-plant residues;
    - Conditioning processes for the use of residues and low-quality iron ore grades, like agglomeration or pelletisation;
    - Implementing Circular Economy and Industrial Symbiosis for long-term goal towards zero- waste.
- Sustainable and efficient scrap management and recycling aiming high-grade steel production with increased scrap rates including:

- Improved mechanical scrap preparation coupled with scrap analyses at various levels;
- Continuous analysis and monitoring of the scrap bulk composition using sensor systems with accompanied model-supported Big Data analytics and Artificial Intelligence (AI) techniques for scrap classification;
- Scrap yard management and charge preparation for quality upgrading;
- Optimised and more flexible primary and secondary steelmaking processes considering enhanced scrap rates.

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

Call - TWIN GREEN AND DIGITAL TRANSITION 2023 TWO STAGE

HORIZON-CL4-2023-TWIN-TRANSITION-01-TWO-STAGE

Conditions for the Call

Indicative budget(s)[41]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[42]	Indicative number of projects expected to be funded
		2023		
Opening: 08 Dec 2022 Deadline(s): 07 Mar 2023 (First Stage), 05 Oct 2023 (Second Stage)				
HORIZON-CL4-2023-TWIN-TRANSITION-01-11	RIA	12.00	5.00 to 6.00	2
Overall indicative budget		12.00		

General conditions relating to this call

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

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

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

A New Way to Build, accelerating disruptive change in construction

Proposals are invited against the following topic(s):

HORIZON-CL4-2023-TWIN-TRANSITION-01-11: Intelligent data acquisition and analysis of materials and products in existing built works (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: Applicants submitting a proposal under the blind evaluation pilot (see General Annex F) must not disclose their organisation names, acronyms, logos, nor names of personnel in Part B of their first stage application (see General Annex E).
Eligibility	The conditions are described in General Annex B. The following

conditions	exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: This topic is part of the blind evaluation pilot under which first stage proposals will be evaluated blindly.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [43].

Expected Outcome:

- Faster and less labour-intensive identification, analysis and digitisation of materials and products from existing built works
- Increased supply of secondary materials and construction products for reuse, thus reducing the resource- and energy-intensity of the construction sector
- Reduction in construction and demolition waste
- Improved facility to re-use and repair construction products
- Improvements to labour productivity as a result of using the developed solutions

Scope: Existing built works (buildings and infrastructure) can potentially act as a significant 'material bank', providing a rich source of secondary materials and products for construction. This requires identification and analysis of the asset's components and materials, which typically involves slow, labour-intensive and costly processes. There is a need to research new digitally powered techniques and technologies that would rapidly and accurately identify,

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

analyse and record existing construction materials, products and components, facilitating their use in a circular economy and reducing life cycle impacts including embodied carbon. Proposals should therefore aim to foster selective deconstruction, separation of hazardous materials, sorting and high-quality recycling. They would thus contribute to the aims of the New European Bauhaus.

Proposals should:

- Develop new techniques and technologies to rapidly identify materials, construction products and components of existing built works, or works that have undergone demolition
- Develop solutions that would rapidly analyse the properties and characteristics of materials, construction products and components, which may include for example material composition, dimensions, mass, technical/mechanical properties and performance, health and safety aspects such as performance in case of fire and the presence of hazardous substances such as asbestos, fixing methods, repair needs, or other aspects
- Develop solutions to digitally record, categorise and tag existing materials, construction products and elements for their eventual use on the market and inclusion in relevant software tools and databases. Proposals should also support the development of existing tools and databases, where relevant, and ensure that relevant actors across the construction ecosystem are consulted in their development, and take into account SSH aspects of this.
- Develop solutions that would analyse the suitability of identified elements for use in a circular economy including undergoing appropriate reuse, repair or recycling processes, or conversely to label them as waste including the necessary separation and sorting
- Research ways in which complex or concealed elements can be identified and analysed, for example materials within the make-up of walls and floors, hidden structures, or composite products
- Address ways to make circular use of the identified elements as secondary materials or reused products on the market in construction projects, and to track them and their characteristics over asset life cycles
- Address ways in which the characteristics of identified elements could be presented in a user-friendly manner to relevant actors such as construction professionals, including on-site workers, designers, architects and developers. This should include consideration of SSH and business model aspects.
- Build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed, for example in relation to product databases and cross-border collaboration.

- Present a strategy for skills development, associating social partners where relevant, integrating SSH aspects and including relevant tools such as MOOCs (massive open online courses).

- Build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms, such as the New European Bauhaus, data spaces under the Digital Europe programme, or the Built4People partnership under Horizon Europe.

- Seek to integrate insights from social sciences and humanities to maximise economic and social impact.

Call - TWIN GREEN AND DIGITAL TRANSITION 2024

HORIZON-CL4-2024-TWIN-TRANSITION-01

Conditions for the Call

Indicative budget(s)[44]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[45]	Indicative number of projects expected to be funded
		2024		
Opening: 19 Sep 2023 Deadline(s): 07 Feb 2024				
HORIZON-CL4-2024-TWIN-TRANSITION-01-03	RIA	35.00	5.00 to 7.00	5
HORIZON-CL4-2024-TWIN-TRANSITION-01-05	RIA	36.00	4.00 to 6.00	6
HORIZON-CL4-2024-TWIN-TRANSITION-01-32	IA	30.00	10.00 to 15.00	2

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

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

HORIZON-CL4-2024-TWIN-TRANSITION-01-34	RIA	20.00	8.00 to 10.00	2
HORIZON-CL4-2024-TWIN-TRANSITION-01-35	IA	30.00	10.00 to 15.00	2
HORIZON-CL4-2024-TWIN-TRANSITION-01-38	IA	40.00	15.00 to 20.00	2
HORIZON-CL4-2024-TWIN-TRANSITION-01-41	RIA	30.00	10.00 to 12.00	3
HORIZON-CL4-2024-TWIN-TRANSITION-01-44	IA	10.00	3.00 to 5.00	2
HORIZON-CL4-2024-TWIN-TRANSITION-01-46	RIA	20.00	3.00 to 5.00	4
Overall indicative budget		251.00		

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

Manufacturing Industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-03: Manufacturing as a Service: Technologies for customised, flexible, and decentralised production on demand (Made in Europe Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 5.00 and 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 35.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [46].

Expected Outcome:

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

- Easy access to flexible and decentralised manufacturing and remanufacturing capacities, especially for SMEs, reducing the required investments for manufacturers while enabling them to use more sustainable and circular facilities.

- Availability of automation, emerging and digital technologies for the servitisation of manufacturing assets assuring optimal performance, fast reconfiguration and upgrade with minimal downtime, remote monitoring and predictive maintenance via trusted, secure and interoperable cross-company data exchange.

- Improved value chain integration through the availability of technologies and models for securely exchanging and leveraging life-cycle data of servitised manufacturing assets, also in view of the reuse or recycle of assets, components, and materials.

Scope: Manufacturing as a Service (MaaS) is a distributed system of production in which resources (including data and software) are offered as services, allowing manufacturers to access distributed providers to implement their manufacturing processes. The servitisation of manufacturing resources contributes significantly to production flexibility and responsiveness, enabling production on demand for many product categories. Suppliers of manufacturing systems and of integration technologies design and offer interoperable services in close partnership with manufacturing companies, while other providers in the value chain can offer additional services. Secure, real-time data exchange between the companies involved enables quick response times.

This topic aims at further developing and integrating the technologies needed for the successful implementation of MaaS allowing to manufacture “on demand” a large choice of customised products, with high flexibility and short lead time, by using distributed facilities as a service and exploiting unused production capacities, also by rapid re-purposing of manufacturing machines. The objective will be achieved through platforms for fast data exchange and seamless, data-driven, standards-based automation of inter-company processes beyond the factory boundaries.

Integration with digital design, development of design libraries and workflow templates, and advanced technologies such as digital twins, real-time AI-based decision support systems, and next-generation Manufacturing Execution Systems should also be considered where appropriate, with the objective to optimise the entire life-cycle of the product in terms of circularity, sustainability and reusability, using product life cycle assessments whenever appropriate.

Interoperability is a core requirement for MaaS; for this reason, research will build on existing standards or contribute to standardization where relevant, taking also into account the contributions of upcoming EU initiatives like the Digital Product Passport or the Manufacturing Data Spaces.

Results should be demonstrated through at least two realistic use cases, based on different supply chains or industry sectors.

Proposals should explain how the proposed approach contributes to the competitiveness of industry and the sustainability and circularity of production and logistics, through measurable targets.

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 "Made in Europe".

HORIZON-CL4-2024-TWIN-TRANSITION-01-05: Technologies/solutions to support circularity for manufacturing (Made in Europe Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 36.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Manufacturing industry should benefit from the following outcomes:

- Assessing the environmental impact of their products, including the flow of products after their use to reduce product and raw material waste with the support of digital technologies;

- Achieving a considerable net reduction of the environmental impact through the use of innovative modelling and simulation software that allows transport and manufacture monitoring, ultimately driving the decarbonisation of the manufacturing industry;

- Facilitating the development and uptake of digital tools/platforms such as the EU Digital Product Passport, to increase traceability and characterisation of materials and products (e.g. at analytical research infrastructures), including environmental footprint and quality;

- Removing barriers in the uptake of the digital tools from the market will be addressed and the workforce will be empowered through new skills.

Scope: Manufacturing plays a key role in achieving the twin transition goal through enhancing circularity, facilitating decarbonisation whilst enhancing competitiveness. A broad range of digital technologies and engineering tools can be employed to achieve the systemic circularity of the European manufacturers.

Data pooling and sharing among sectors and across the whole value chain, as well as the use of external environmental impact data such as LCA-data, would facilitate recycling and remanufacturing, by modelling and monitoring the life cycle of products and components. Such data pooling would enable a better insight into the environmental footprint, including the CO_2-footprint, of products and components. To achieve that, there is a need to build trust by ensuring data exchange and interoperability across industry sectors and relevant stakeholders, while also focusing on aspects like data quality, cybersecurity, reliability, and accessibility. The forthcoming Sustainable Product Framework (SPI) [47] that has been announced as part of the Circular Economy Action Plan 2.0 in 2020 is proposing the Digital Product Passport to electronically register, process and share product-related information amongst supply chain businesses, authorities and consumers, therefore the manufacturers should be prepared for its implementation.

The transition to the circular manufacturing requires a new mindset and expertise. All the technological improvements of the manufacturing process should always support the human aspect in order to uptake these improvements through upskilling and reskilling of the manufacturing workforce. The workforce should be engaged in the realization of circular approaches and the new manufacturing technologies.

Proposals should cover all of the following aspects:

- Develop new approaches of Artificial Intelligence to forecasts the environmental impact, also considering the quantity and state of products after their use;

- Develop innovative simulation and modelling software or built on existing solutions fostering new manufacturing capabilities with a view to a more efficient and more sustainable product design. This optimization process should consider the various steps

[47] https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en

of the value chain focusing on the environmental impact. Additional ecological impacts arising from the use of the modelling or simulation software should be considered;

- Develop digital platforms/ tools build on existing interoperability architectures (such as the Asset Administration Shell), that will enable the manufacturers to implement the Digital Product Passport initiative. The proposals should focus on gathering relevant data, material and product tracking and tracing, certification protocols for secure re-used materials and components among sectors;

- Enhance the human involvement in the development of the circularity aspects and new technologies.

Links may be established with relevant cases emerging from the CSA project HORIZON-CL4-2023-RESILIENCE-01-39.

International cooperation is encouraged, especially with Japan, S. Korea, US, Canada, and Australia.

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

Proposals should take into account relevant international standards and activities supported under the Digital Europe programme, e.g. in the area of Manufacturing Data Spaces.

Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed, leveraging on existing ontologies and metadata and though the implementation of the FAIR data principles.[48]

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. Collaboration with EIT Manufacturing is encouraged, in particular on the development of skills.

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

Energy Intensive Process Industries

Energy-efficient and climate neutral process industries
Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-32: Optimisation of thermal energy flows in the process industry (Processes4Planet partnership) (IA)

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

[48] Turning FAIR into reality: https://ec.europa.eu/info/sites/default/files/turning_fair_into_reality_1.pdf

contribution per project	10.00 and 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by enhancing process industries energy efficiency, ensuring process flexibility and capturing the full potential of renewable energy (related to P4Planet operational objective 1).

Projects are expected to contribute to the following outcomes:

- Energy intensive industries will be enabled to increase their energy efficiency through optimisation of thermal energy flows between processes, minimizing losses and using all levels of energy;
- Demonstrate highly process-integrated solutions that offer better opportunities to increase energy efficiency and reduce investment cost of high temperature installations;
- Demonstrate a substantial increase in flexibility of the processes;
- Contribute to achieving EU Climate neutrality goal and becoming independent from fossil fuel and fossil fuel imports as put forward in the REPowerEU Plan[49];
- Enable the increase of the competitiveness and resilience of the European process industry.

Scope: More than 60%[50] of the overall energy used in the process industry is process heating. The topic focuses on highly process-integrated technologies that allow heat recovery and use of high temperature installations. Heat storage, when needed, should be intermediary only. One example could be the adaptation and integration of heat pumps for high temperature (150-250 °C) applications for large thermal capacity (~1-20 MW), but not only – examples

[49] COM/2022/230 final

[50] https://www.sintef.no/globalassets/sintef-energi/industrial-heat-pump-whitepaper/2020-07-10-whitepaper-ihp-a4.pdf

could also encompass the direct use of excess heat by e.g., the adaptation and integration of advanced heat exchangers.

The proposals under this topic should:

- Demonstrate the efficient integration and adaptation of heat exchanger or heat pumps into high temperature processes and equipment taking energy not only from air but also warm materials or liquid flows;
- Use high safety standard technologies and fluids with low environmental impact;
- Consider, where necessary, the use of advanced materials in the process development;
- Demonstrate the decrease of energy intensity of output level (intermediate, final product).

The inclusion of a GHG avoidance methodology[51] is recommended and should provide detailed description of baselines and projected reductions.

The heat power generation is out of the scope of this topic. The proposals should include energy efficiency, techno-economic and life-cycle assessments considering the overall process.

Proposals submitted under this topic should include a sound business case and strong exploitation strategy, as outlined in the introduction to this Destination. As a project output a more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation and deployment (feasibility study, business plan and financial model). This should also include the assessment of possible societal and environmental impact and implications for the workplace (such as skills, organisational change).

Research must build on existing standards or contribute to standardisation. Where relevant, interoperability for data sharing should be addressed.

Proposals 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 Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-34: Renewable hydrogen used as feedstock in innovative production routes (Processes4Planet Partnership) (RIA)

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

[51] That could follow Innovation Fund methodology: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

contribution per project	8.00 and 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by developing new processes integrating renewable hydrogen that can replace fossil feedstock-based processes, enabling the full potential of renewable energy sources, and ensuring process flexibility (related to P4Planet operational objectives 1 and 2).

Projects are expected to contribute to the following outcomes:

- Enable the technical and economic feasibility of innovative production routes using hydrogen as feedstock[52] demonstrated and validated at suitable scale against current state of art of industrial processes;
- Enable the efficient use and integration of hydrogen as a feedstock in innovative industry processes, considering also fluctuation of availability;
- Support the increased utilisation of renewable energy sources combined with digital technologies in the process industries, thereby contributing to the independency on fossil fuel and fossil fuel imports as put forward in the REPowerEU Plan[53];
- Contribute to EU Climate neutrality goal by proving the effectiveness of the GHG emission avoidance in the targeted process;
- Support Mission Innovation 2.0 NZEID on ‘Net-zero Industries’ and its ambition via networking and dissemination activities.

Scope: Hydrogen produced from renewable energy sources does not lead to direct carbon dioxide emissions when used and it can offer solutions to decrease GHG emissions in industrial processes. Hydrogen is thus an important enabler for meeting the 2050 climate

[52] The production as well as the use of hydrogen as energy carrier is excluded from the scope of the topic.
[53] COM/2022/230 final

neutrality goal. In the energy intensive process industries, hydrogen can be used either as feedstock (chemical or reducing agent) or as an energy carrier. The integration of renewable hydrogen into new production routes as a feedstock will lead to major GHG emission reductions across several European industry sectors.

Currently, hydrogen is largely used in industrial sectors such as the chemical industries and refineries. In addition to the current processes, there are different production pathways under development using hydrogen as a chemical feedstock in low-carbon industrial processes. Hydrogen could be used as reducing agent in the production and recovery of metals, biogenic and circular carbon optimisation or in new process routes to produce platform chemicals (e.g., carbon-based waste and side streams or biomass). The proposals under this topic should:

- Develop innovative production routes using hydrogen as feedstock;
- Evaluate the efficient integration of the new production process into the processing line, including downstream and upstream;
- Design production process coupled/integrated with renewable hydrogen by making the best use of simulation, modelling and IT tools;
- Include energy efficiency, techno-economic and life-cycle assessments considering the efficient use of the hydrogen as well as the value of the by-products, and the value chain from hydrogen production, storage, distribution and usage.

The use of hydrogen as feedstock to produce fuels is out of the scope of this topic. Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination. Societal and environmental impact and implications for the workplace (such as skills, organisational change) should be outlined.

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national, or regional initiatives and funding programmes and platforms. Where relevant, proposals could liaise with the Clean Hydrogen Joint Undertaking and are encouraged to contribute and participate to the activities of the TRUST database and the hydrogen observatory.

This topic implements the co-programmed European partnership Processes4Planet.

HORIZON-CL4-2024-TWIN-TRANSITION-01-35: Turning CO2 emissions from the process industry to feedstock (Processes4Planet partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Technology Readiness Level	Activities are expected to start at TRL 5-6 and achieve TRL 7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: The funding rate is up to 60% of the eligible costs as a way to increase the contribution of industry to this co-programmed partnership. This funding rate applies to both members and non-members of the partnership, except for non-profit legal entities, where the funding rate is up to 100% of the total eligible costs.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by developing efficient CO/CO2 capture and purification technologies, in combination with valorisation routes; that will drive the partnership's innovation portfolio towards first of a kind demonstrator and de-risk investment (related P4Planet operational objectives 3, 4 and 9).

Projects are expected to contribute to the following outcomes:

- Master the capture, purification and conversion of CO/CO2 from process industry point sources and utilization of renewable energy at reasonable costs to pave the road to the production of a large range of chemicals and materials;
- Showcase the system effectiveness for the GHG emission avoidance in the process industries as well as the scalability and the cost efficiency of the proposed concept;
- Enable the economic viability of the entire unit to compete with the existing state of the art production of the same or equivalent products (e.g., fossil-based production of chemicals and materials);
- Prove the efficient integration and use of renewable energy sources, and where relevant account for their intermittency and the possibility to offer demand-response flexibility;
- Enable the increase of the competitiveness and resilience of the European process industry.

Scope: The proposals submitted under this topic are expected to demonstrate the economic viability of the efficient capture and utilisation of CO/CO2 streams from point sources (e.g., large and medium industrial installations such as steel, cement, refining and chemical plants) converting the streams into added value chemicals and materials in near to production size systems. The technologies proposed should support cross-sectorial concepts and sector integration.

The semi-industrial scale demonstrators[54] proposed should:

- Process significant amounts of CO/CO2 containing emissions from energy intensive process industries;
- Demonstrate process and cost efficient environmentally friendly technologies for: capture[55] and fit for purpose purification approaches[56] while ensuring the maximum process efficiency;
- Demonstrate the cost efficient environmentally friendly conversion of CO/CO_2 into chemicals and materials including any relevant auxiliary required for the process (such the formulation of reliable catalyst at the required scale) and if relevant process-integrated downstream products;
- Evaluate the energy efficiency for the overall CCU process and where relevant flexibility considerations for the efficient use of renewable energy for capture and conversion;
- Encompass the use of advanced monitoring and control techniques and integration of advanced digital technologies, which enable optimisation of the overall system;
- Contribute to an integration effort to realize fully integrated capture and utilization systems, including the optimization of materials, process interfaces, and ultimately device architectures and to promote maximum energy efficiency;
- Include techno-economic analysis, including social and environmental impact.

The proposals will integrate technologies to make them practically and economically viable in the process industries optimising CAPEX and reducing CO2 abatement costs. This should be demonstrated through at least one realistic use case with demonstrable economic return developed in closed cooperation between CO2 industrial emitters, users and technology providers.

The inclusion of a GHG avoidance methodology[57] is recommended and should provide detailed descriptions of baselines and projected emissions reduction.

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54 at a scale that allows to take economical and technical decisions for a First of a kind (FOAK) plant.

55 Including, for example, use of waste heat in scrubbers, increased mass transport in intensified scrubbers, electrified systems with promising novel materials and equipment design. These are just illustrative examples.

56 Including, for example, advanced membranes and environmentally friendly absorbents for cleaning formulations, compression, drying, concentration, Pressure Swing Adsorption etc.). These are just illustrative examples.

Proposals submitted under this topic should include a strong business case and sound exploitation strategy, as outlined in the introduction to this Destination. As a project output a more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan and financial model) indicating the possible funding sources to be potentially used (e.g. Innovation Fund, InvestEU, ESIF).

Proposals should build on or seek collaboration with existing projects and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms and are encouraged to consider the use of their expected outcomes in a wider approach that might benefit the establishment of Hubs for Circularity.

Where synergies are possible with projects from topic HORIZON-CL5-2024-D3-02-11, cooperation activities are encouraged.

This topic implements the co-programmed European partnership Processes4Planet.

Circularity and Zero Pollution in process industries
Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-38: Hubs for circularity for industrialised urban peripheral areas (Processes4Planet partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 15.00 and 20.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 40.00 million.
Type of Action	Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

[57] That should follow Innovation Fund methodology: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 7 by the end of the project – see General Annex B.

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by demonstrating hubs for circularity (H4Cs) concepts, fostering circularity within and beyond process industries and driving the partnership's innovation portfolio towards "First of a kind" demonstrators to de-risk investment for subsequent roll-out. (P4Planet operational objectives 8 and 9).

Projects are expected to contribute to the following outcomes:

- Demonstrate zero urban waste in a near commercial scale environment through systemic resource recovery as alternative material feedstock; a decrease of GHG emissions is also expected by explicitly addressing the reduced flow of goods (due to geographical proximity);
- Reduce the freshwater consumption of the urban area by 50%, and re-use 90% of the solid waste generated by the water treatment;
- Citizens living in cities will benefit from a healthier environment through industrial/urban symbiosis by lowering emissions through circular and renewable energy sources and waste reduction;
- Use urban/industrial symbiosis and cross-sectorial cooperation to pave the way for achieving the EU Green Deal and "Fit for 55" package objectives: providing recommendations for optimized regional framework conditions by highlighting barriers and suitable innovation-oriented policies and looking for possible synergies with the cities selected by the Cities Mission[58] .

Scope: Urban areas with high volumes of waste (household and end of life consumer waste) should closely interact with adjacent industries to jointly minimize their CO2 footprint and improve their waste management, thus contributing together to the valorisation of secondary materials and overall circularity. The hubs for circularity (H4C) concept is a pathway to exploit local synergies for the deployment of innovative solutions engaging regional resource management actors in strategic nodes where novel value chains valorising a significant part of end-of-life wastes could connect within and across regions.

The concept of Industrial-Urban Symbiosis (I-US) should be demonstrated at semi-industrial scale[59], by systemically re-integrating the flow of urban wastes in process industries and, where applicable downstream in manufacturing, construction, and other industries. Full

[58] Not mandatory.
[59] at a scale that allows to take economical and technical decisions for a First of a kind (FOAK) plant.

attention should be paid on upcycling of secondary materials or products instead of downcycling.

Proposals are expected to address:

- A systemic solution for a H4C including technological and non-technological as well as regional and interregional aspects: closing circularity loops for mixed/combined materials streams based on upcycling and process-based approach to a range of recycling solutions including conversion and downstream, complex multi-material streams, valorisation of waste streams (urban mining);

- Proposals can address either materials, water or energy, or a combination of those. Management and processing of secondary resource streams through e.g., collection, disassembly, sorting, purification, concentration, recycling (including but not limited to chemical, metallurgical, or bio-based resources), logistics and trading for their valorisation for the use as feedstock for other plants and companies across sectors and/or across value chains. Connections with manufacturing industries are expected. The remaining non-recyclable fractions will be used to optimal energy recovery;

- Digital tool, recycling and sensor-based waste sorting, modelling tools, including material passport and information on material streams, as basis for resource management towards fully integrated LCA and Material Flow Analysis MFA (on diverse levels) and for creating transparency and matchmaking opportunities across hubs. Prepare for tagging/matrix for complex consumer products and innovative approach to end-of life materials;

- Establish IT infrastructures and tools that provide a secure basis for the integrated management and the preservation of confidentiality of sensitive data, it might not be in the same location as the demonstrator and serve the needs of multiple hubs;

- Consider when applicable the co-development of industrial decarbonization strategies with urban district heating networks, i.e., based on a socio-economic optimum in the cascading re-use of waste heat and using the district heating network to supply low temperature process heat[60];

- Use established reporting methodologies for the assessment of industrial symbiosis activities and exchanges, including Symbiosis Readiness Levels (SRLs) and best practices established by the European H4C Community of Practice (ECoP). In addition, interact with the ECoP for support, best practice and knowledge exchange on technological and non-technological issues;

- Plan in detail the replication and adaption of the concept, including the simulation and the business case and exploitation strategy of the First of a Kind hubs, in two to three alternative locations in close cooperation with the relevant local actors. The replication

[60] Waste incineration coupled with district heating is excluded.

cases should be part of the proposal. Include local and regional authorities in an active collaboration to create favourable and coherent place-based framework conditions;

- Favour participative management with the local community and study the evolution of the social impact of the hub, whilst also considering gender perspective and inclusiveness;

- Implement a social innovation action involving at least one of the local community actors and, additional actions to facilitate relations and to involve the local community actors e.g., exchanging knowledge with the educational establishments and developing flexible learning resources;

- Include a plan to extend the hub to additional players parties (especially waste management and associations, new market entries and other relevant stakeholders) who also should benefit and multiply the local/regional synergies in the co-implementation of the identified innovations and solutions within the next five years.

Proposals submitted under this topic should include a business case and exploitation strategy, as outlined in the introduction to this Destination As a project output a more elaborated exploitation plan should be developed including preliminary plans for scalability, commercialisation, and deployment (feasibility study, business plan and financial model) indicating the possible funding sources to be potentially used (e.g., Innovation Fund, LIFE, InvestEU, ESIF).

Relevant indicators and metrics, with baseline values, should be stated clearly in the proposal. Research must build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.

Clustering and cooperation with other selected projects under this topic and other relevant topics in Horizon Europe (e.g., HORIZON-CL4-2023-TWIN-TRANSITION-01-42 or HORIZON-CL4-2023-RESILIENCE-01-05), with European initiatives (as for example: Circular Cities and Regions Initiative (CCRI) and European Circular Economy Stakeholder Panel (ECESP)), as well as building on existing projects is strongly encouraged (see also Industrial Symbiosis Report of March 2020[61]).

This topic aims to support the goals of the smart cities mission by contributing to a healthier urban industrial symbiosis through waste reduction.

This topic implements the co-programmed European partnership Processes4Planet.

[61] Study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation: Findings and recommendations, March 2020 http://ec.europa.eu/info/publications/study-and-portfolio-review-projects-industrial-symbiosis-dg-research-and-innovation-findings-and-recommendations_en

HORIZON-CL4-2024-TWIN-TRANSITION-01-41: Breakthroughs to improve process industry resource efficiency (Processes4Planet partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 10.00 and 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 30.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [62].

Expected Outcome: Projects outcomes will enable achievement of the objectives of Processes4Planet partnership by designing processes for maximum resource efficiency (related to P4Planet operational objective 5).

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

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

- Achieve a step change in the process industry's green transformation by improving by at least 30 % the industrial processes resource [63] efficiency compared to the state of the art;
- Enable the techno-economic feasibility of novel technologies and processes, demonstrated and validated at suitable scale against current industrial processes to produce the same products;
- Overall positive environmental and if relevant health and safety impact demonstrated;
- Reduce the CO2 intensity of the process industry and contribute to the climate neutrality goal;
- Enable the increase of the competitiveness and resilience of the European process industry.

Scope: Process industries will greatly benefit from radically new approaches that will lead to a much higher resource efficiency (including higher selectivity), producing less low-value by-products and waste and enabling the handing of a higher feedstock variability, and ultimately leading to lower level of GHG emissions linked to the process industries. To reach ambitious targets regarding resource efficiency, disruptive process technologies must be developed in addition to process efficiency options for existing technologies.

Proposals should:

- Develop disruptive process technologies to improve resource efficiency, such as those based on: process intensification (e.g., 3D printed processes equipment, coupling of process steps, new processes that integrate multiple reaction steps, activation of molecules using renewable energy via alternative processes e.g. microwave, plasma); or to prevent and minimise waste generation by, e.g. processes that adjust in real time to feedstock changes or that have tighter processing control solutions to ensure higher yields from complex and fluctuating raw material feeds;
- Where relevant advanced process technologies and their combinations need to be developed and supported by advanced materials innovation and the implementation of enabling digital technologies including advanced concepts on process control and data driven Artificial Intelligence.

The proposals should include energy efficiency, techno-economic and life-cycle assessments considering the overall process. This should also include the assessment of possible societal and environmental impact and the effects on the workplaces (skills, organisational change, and others).

[63] Resource in the context of this topic means material as energy or water efficiency are covered by topics TWIN-TRANSITION-01-31: Energy efficiency breakthroughs in the process industries (Processes4Planet partnership) (RIA) and HORIZON-CL4-2024-TWIN-TRANSITION-01-40 : Sustainable and efficient industrial water consumption: through energy and solute recovery, topics

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. Where relevant interoperability for data sharing should be addressed.

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

This topic implements the co-programmed European partnership Processes4Planet.

Clean steel
Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-44: Digital transformation and ensuring a better use of industrial data, which can optimise steel supply chains (Clean Steel Partnership) (IA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to start at TRL 5 and achieve TRL 6-7 by the end of the project – see General Annex B.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). [64].

Expected Outcome: As mentioned in the Clean Steel Partnership (CSP) Strategic Research and Innovation Agenda (SRIA),[65] digitalisation and social aspects are both addressed in the Building Block (BB) 10 because of their strong role of enabling the carbon neutral transition. In particular, digitalisation enables all the other BBs, as evidenced in Table 12 of the CSP SRIA. So, the optimal deployment of digitalisation implementing the integrated approach along the steel value chain must be provided according to outcomes and scopes defined below.

Projects are expected to contribute to one or more of the following outcomes:

- Increasing awareness and effectivity leading to total safety of steel manufacturing processes and CO_2 reduction through digital transition with better use of industrial data;
- Extension of inline and real-time tools to monitor and control sustainability of the running process conditions, to set up countermeasures to stay into the optimal process window; this includes, but is not limited to, energy and (intermediate) product quality forecasting, online comparison between forecast and realisation, control of metal slag;
- Enhancement of the in-line classification of feedstock and intermediate products through the continuous analysis of composition and bulk properties by applying holistic soft sensor approaches considering the assembly of sensors, specific models, and advanced data processing according to SRIA (specifically see page 41, 42 of the SRIA);
- Increasing effective and secure data sharing in steel plants to realise the seamless digital integration of the value chain and the interoperability of systems and tools by implementation of existing and enhanced standardised protocols;
- Novel sensors and models for real-time process control (see page 41, 42 of the SRIA), such as, but not limited to, metal slag parameters (e.g., composition) and temperature measurement, slag analysis, off-gas analysis, energy forecasting to match demand and offered mix in the power grid considering energy generated from renewable sources; the latter could require cooperation between steel experts and electric power players in the market. The expected outcome is an enhanced merging of planning activities and approaches to run plant processes;
- Application of digital technologies such as, for example, Digital Twins and/or enhanced statistical analysis, machine learning (ML) algorithms, or artificial intelligence (AI) to

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

65 https://www.estep.eu/assets/CleanSteelMembersection/CSP-SRIA-Oct2021-clean.pdf

develop decision-supported planning and process monitoring tools operable in offline or online modes;

- Traceability of materials and process information throughout the value chain to promote improved product quality, efficiency and process integration control (including multi-scale modelling of structure, and structure vs. properties correlations).

Scope: Multidisciplinary research activities should address one or more of the following topics:

- Novel sensors, soft sensors and related models and approaches to reduce the carbon footprint by merging the use of sensors and data processing capabilities for huge volumes of heterogeneous data streams; systems / tools enabling the transition from legacy into new architectures capable to supply data in a seamless way "when, where and what" including the development and testing of implementation guidelines. This should enable the traceability of materials and process information throughout the value chain to promote improved product quality, efficiency and integrated process control and management (including multi-scale modelling of structure, and structure vs. properties correlations);

- Statistics coupled with outstanding analytical capabilities to improve data quality and to help steel plant operators to increase the process yield and to improve the quality of intermediates and final steel products, while addressing the best approach to limit carbon emissions;

- The application of combinations of advanced digital technologies, such as but not limited to model-based, knowledge-based and data-based methods, artificial intelligence (AI), supercomputing, edge computing, cloud systems and internet of things (IoT) to develop decision-supported planning and process monitoring tools for clean steel manufacturing operable in offline or online modes;

- Involvement of operators and process experts in the design and development phases of digital technology integration, ensuring the uptake of human experiences and a user-friendly processing of results for easier industrial integration (see Table 12 row 3 of the CSP SRIA[66]). This may also include issues of skilling and standardisation and man-machine interaction by deploying Virtual and Augmented Reality techniques.

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

HORIZON-CL4-2024-TWIN-TRANSITION-01-46: CO2-neutral steel production with hydrogen, secondary carbon carriers and electricity OR innovative steel applications for low CO2 emissions (Clean Steel Partnership) (RIA)

Specific conditions

[66] https://www.estep.eu/assets/CleanSteelMembersection/CSP-SRIA-Oct2021-clean.pdf

Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 3.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 5-6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: To ensure a balanced portfolio covering the two technology areas in the scope below, grants will be awarded to applications not only in order of ranking, but also to at least one project in each technology area, provided that the applications attain all thresholds.

Expected Outcome: The establishment of a clean steel market will be based upon decarbonisation of the steel making and production through the use of advanced and breakthrough technologies. The modification and change of production routes will have an impact onto the design of customised steel products and its applications in the market.

Projects outcomes will enable achieving the objectives of the Clean Steel Partnership (CSP) by contributing to one of the following two aspects:

1. Enhance CO_2-neutral steel production with hydrogen, secondary carbon carriers and electricity;

2. Contribute to innovative steel applications for low CO_2 emissions.

Projects related to the above point 1 are expected to contribute to one or more of the following outcomes:

- Introducing the use of secondary carbon sources, including waste and residues of biological origin[67] in steelmaking processes to target improved sustainability and to allow a technically and economically feasible transition to reduce the use of fossil carbon as fuel or reducing agent;

[67] In the CSP SRIA "biomass" means the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin as defined in the Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources (EU,2018).

- Combining the reduction of fossil carbon-related emissions obtained with technologies to reduce steelwork energy consumption with improvements in the materials and energy flows;

- Reduction of carbon footprint by incrementally adapting to the use of low-CO_2 hydrogen to heat up steel for rolling, shaping, and heat treatment, considering also a coupling between hydrogen and/or electrical heating and fuel-flexibility concepts;

- Valorisation of non-conventional ores, e.g., in (photo)electrolysis processes;

- Substitution of fossil sources as carburiser and slag foaming agent by alternative materials in electric arc furnaces (EAF) and contribute to achieve low-CO_2 steel production;

- Enhancing the handling of carbon-bearing residues and recovery of metal contents from low-value residues by pre-reduction or reduction smelting with hydrogen and/or electricity;

- Identify and analyse the amount of European existing technologies that could be efficiently retrofitted to CO_2 neutral solutions (e.g. H_2 DRI). Differentiate between incremental retrofits and retrofits allowing for production of carbon-free iron and steel. The final evaluation should provide a comprehensive overview of technical possibilities along with possible implementation timelines, and indicate on emission reduction stages and required financial investments. Projects awarded under this point are expected to involve among the consortium a balanced representation from academia, research centres and industry and to be developed in contact with the European Commission.

OR

Projects related to the above point 2 are expected to contribute to at least two of the following outcomes, which require designing steel alloys and products and validating their application for the clean steel market (related to the CSP specific objective 6, see also Building Block 12: Innovative steel applications for low CO_2 emissions in SRIA[68]):

- New or modified alloying concepts, downstream processing and manufacturing processes for new clean steel grades, as well as derivation of new test methods that are closer to reality into the industrial application;

- Manufacture steels with improved life cycle contributions to CO_2 emissions reduction; this is the case for, but not limited to, the transport sector, which includes improved possibilities for re-use and re-manufacture; this includes also innovative manufacturing technologies for steel grades supporting decarbonisation like, but not limited to, electric strip;

[68] https://www.estep.eu/assets/CleanSteelMembersection/CSP-SRIA-Oct2021-clean.pdf

- Clean steel grades with improved in-use properties obtained by controlling the application properties (e.g., yield strength and/or high ductility steels, fatigue, embrittlement, internal and external corrosion and other properties relevant to service life in the application) supported by known or new techniques (e.g., machine learning (ML), metallurgical / thermodynamic simulations, multi-scale models, defect vs. structure vs. properties correlations, finite element methods (FEM), realistic and applied testing methods) to realise the desired steel grade characteristics;

- Innovative simulation methods and tools (e.g., Calculation of PHAse Diagrams (CALPHAD), crystal plasticity, artificial intelligence (AI), machine learning (ML), realistic and application-oriented testing methods, multi-scale modelling, and microstructure, defects and properties prediction tools, digital twins etc.) to accelerate the development processes of the mentioned clean steel grades and their manufacturing processes;

- Advanced grades of steel for use in efficient high temperature processes including, for instance, thermal reactors for waste recovery;

- Advanced grades of steel for use in the railway's systems of high-speed trains to assure high quality, good weldability, and very high mechanical properties, including high yield strength, metal-to-metal wear resistance, and high rolling contact fatigue resistance;

- High-performance structural steels (e.g., high-strength, high-pressure resistant, creep resistant, oxidation resistant, etc.) not containing critical strategic elements (such as, V, Nb, Ti, etc.) and/or characterized by increased tolerance to the content of contaminants in the scrap, such as for instance Cu;

- Steel grades with increased use of low-quality input materials (e.g., scrap, secondary raw materials, ores / dust, etc.) by new knowledge of the influences on the application properties of manufactured steel products tested under realistic operating conditions, taking into account the entire manufacturing process to identify the acceptance of buyers / users (incl. economic / ecological benefits, questionnaires, market research).

Scope: Proposals should aim at one of the following two aspects, corresponding respectively to the points 1) and 2) outlined under the expected outcomes section:

1. Proposals should relate to metal reduction processes using hydrogen, renewable electricity, and/or secondary carbon carriers, and/or to replace fossil fuels and reductants in steelmaking and in downstream processing in steel plants. Proposals under this topic are expected to:

- Provide concepts addressing the modifications of the existing and new installations for steel production, such as:

    - Blast furnace–basic oxygen furnace (BF-BOF);

    - Electric arc furnace (EAF);

- Direct reduced iron (DRI) process: In this case, compare the feedstock's iron content requirements necessary for the direct reduction process in comparison with other alternative processes (e.g., electrolysis);
- Alternative reduction processes (such as electrolysis on non-conventional ores);
- Heating and treatment of semi-finished products.

- Such modifications could also concern the internal and external flows of energy and materials to re-use e.g., metallurgical gases (internal re-cycling) and to upgrade them with new sources, e.g., by replacement of fossil carbon, both as reducing agent, and heat sources with hydrogen and alternative carbon sources;
- Consider the integrated preparation (reforming, separation, heating, compression) of external carbon-lean gases or internally recycled CO/CO_2 streams for efficient use as reducing agent, but not limited to or for use in heating process.

OR

1. Proposals should address the conception and production of clean steel for use in established markets and/or in markets having specific demanding or harsh environments. Of interest are steels and steel grades capable to demonstrate for instance high level of yield strength, high level of fatigue, high resistance to pressure, heat, wear, cyclic loads, crash and to severe corrosion conditions. The scope also covers the maximisation of low-quality materials usage and their influence on the product quality. Where appropriate for the study proposed, analytical research infrastructures, such as but not limited to synchrotron and/or neutron facilities, should be considered as capable of providing large amount of statistically relevant data to validate chemistry and structure / morphology and solve challenges concerning hydrogen embrittlement and/or residual stresses. Proposals should demonstrate the CO_2 reduction potential by conception along the advanced / breakthrough manufacturing routes and/or by the application of their innovative steel solution.

Research should contribute to pre-standardisation documents and technical reports to support achieving innovative industrial applications of advanced clean steel grades.

Specific budget needs to be allocated in the project for pursuing dissemination and exploitation activities with the Clean Steel Partnership (e.g. exchange of information, carbon reduction potential etc.).

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

Call - TWIN GREEN AND DIGITAL TRANSITION 2024 TWO STAGE

HORIZON-CL4-2024-TWIN-TRANSITION-01-TWO-STAGE

Conditions for the Call

Indicative budget(s)[69]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[70]	Indicative number of projects expected to be funded
		2024		
Opening: 19 Sep 2023 Deadline(s): 07 Feb 2024 (First Stage), 24 Sep 2024 (Second Stage)				
HORIZON-CL4-2024-TWIN-TRANSITION-01-01	RIA	25.00	4.00 to 5.00	5
HORIZON-CL4-2024-TWIN-TRANSITION-01-12	RIA	12.00	5.00 to 6.00	2
Overall indicative budget		37.00		

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

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

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

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

Manufacturing Industry

Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-01: Bio-intelligent manufacturing industries (Made in Europe Partnership) (RIA)

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 4.00 and 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 25.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: Applicants submitting a proposal under the blind evaluation pilot (see General Annex F) must not disclose their organisation names, acronyms, logos, nor names of personnel in Part B of their first stage application (see General Annex E). In order to include a business case and exploitation strategy, the page limit in General Annex A of the General Annexes is exceptionally extended by 3 pages.
Technology Readiness Level	Activities are expected to start at TRL 4 and achieve TRL 6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: This topic is part of the blind evaluation pilot under which first stage proposals will be evaluated blindly.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the

	Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [71].

Expected Outcome: European manufacturing industries are reinforced through biological transformation; in particular

- Access to bio-intelligent production technologies and architecture;
- Technological advances and improvements in sustainability (in particular SDGs 11, 12 and 13) arising from the integration of bio-intelligent principles, functions, structures and technologies in manufacturing;
- Substitution of raw materials by bio-based materials, or implementation of bio-based or bio-intelligent manufacturing operations, and business models leading to regenerative production.

Scope: The biological transformation of industry is a pioneering frontier that the industry of the Union and Associated Countries can harness to enhance circularity and sustainability, while advancing production efficiency and competitiveness.

The biological transformation of industry involves the integration of bio-intelligent structures, processes, organisms or materials into technology by systematically applying knowledge from biology. This should lead to a necessary convergence of biotechnology with mechanical engineering, production technology and information technology with new possibilities for the flexible adaptation of production and value creation processes to requirements, especially in the context of sustainability.

The biological transformation of industries includes but is not limited to:

- Bio-inspired manufacturing processes (biomimicry, biomimetics);
- Development of bio-intelligent manufacturing systems or tools;
- Expanding opportunities of bio-intelligent and bio-based materials by substituting fossil-based raw materials and limiting the release of microplastics, e.g. in the textile industry;
- A systematic application of the knowledge of nature and/or natural processes aiming at optimising a manufacturing system through a convergence and the integration of technical and biological processes.

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

This transformation can also aid in reducing the carbon footprint of production and products, and foster circularity, while contributing to the competitiveness and digitalisation of the industry of the Union and Associated Countries.

Proposals need to demonstrate the development of digital and green technologies that facilitate the upscaled manufacturing of bio-based or bio-intelligent products in one manufacturing value chain. In addition, sustainable business models need to be developed for production and recycling of the products.

Proposals should address either advanced manufacturing techniques (e.g. additive manufacturing, extrusion, moulding etc.) to process bio-materials or bio-intelligent components for upscaled production; or bio-intelligent production technologies; or combinations of these two approaches.

The focus of this topic is on manufacturing. The development of materials beyond the manufacturing context is excluded.

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, leveraging on existing ontologies and metadata and though the implementation of the FAIR data principles.[72]

Additionally, a strategy for skills development should be presented, associating social partners and civil society where relevant. Collaboration with EIT Manufacturing is encouraged, in particular on the development of skills.

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, for example with Horizon Europe Cluster 6 and its Destination on Circular Economy and Bioeconomy sectors and/or its Partnership Circular Bio-based Europe (CBE)[73].

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

A New Way to Build, accelerating disruptive change in construction

Proposals are invited against the following topic(s):

HORIZON-CL4-2024-TWIN-TRANSITION-01-12: Enhanced assessment, intervention and repair of civil engineering infrastructure (RIA)

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

[72] Turning FAIR into reality: https://ec.europa.eu/info/sites/default/files/turning_fair_into_reality_1.pdf
[73] http://www.cbe.europa.eu

contribution per project	5.00 and 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Admissibility conditions	The conditions are described in General Annex A. The following exceptions apply: Applicants submitting a proposal under the blind evaluation pilot (see General Annex F) must not disclose their organisation names, acronyms, logos, nor names of personnel in Part B of their first stage application (see General Annex E).
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Technology Readiness Level	Activities are expected to achieve TRL 6 by the end of the project – see General Annex B.
Procedure	The procedure is described in General Annex F. The following exceptions apply: This topic is part of the blind evaluation pilot under which first stage proposals will be evaluated blindly.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [74].

Expected Outcome:

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

- Extension of the service life of civil engineering infrastructure, which reduces the need to replace infrastructure, and ultimately in an overall lower CO-2 footprint for such infrastructure

- Faster and more accurate detection and analysis of maintenance and repair needs in existing infrastructure

- Reduction in time between the occurrence of infrastructure maintenance and repair-related problems and the on-site intervention

- Reduced risks to health and safety of workers in carrying out tasks linked to infrastructure maintenance and repair

- Cost savings in terms of both operational costs and deferred or avoided capital investment costs

Scope: Regular maintenance and repair of civil engineering infrastructure extends their service life, which in turn reduces the need for their demolition and replacement and the related negative economic, environmental and climate impacts. However, it can be difficult and cumbersome to identify and address maintenance or repair needs, especially in locations that are difficult to access such as large or tall structures, deep shafts, or where elements are hidden from view. Intervention for maintenance and repair can also involve unnecessary risks to health and safety of workers.

Proposals should:

- Develop new technologies and solutions that facilitate timely identification of maintenance and repair issues in existing civil engineering infrastructure. Examples may include structural weaknesses, unacceptable deformation and fatigue, issues related to moisture including mould growth and corrosion, the effects of weathering and of weather-related events, faults in technical systems, leaks of water or chemicals, or other issues.

- Develop new solutions to monitor and to quickly and accurately analyse and assess the need for intervention, for example via digital twin and simulation technology

- Develop solutions that would intelligently recommend and prioritise relevant and timely action to address the identified maintenance and repair issues. This should include a risk assessment and application of state-of-the-art quality controls and documentation.

- Develop solutions that would carry out rapid, cost effective and safe intervention for maintenance and repair of infrastructure, for example using automated or remotely operated tools, or next generation egocentric AR solutions

- Address ways to reduce the risks involved with maintenance and repair, including the health and safety of workers

- Address ways to digitally record and continually update the maintenance and repair status of infrastructure assets and their component parts
- Build on existing standards or contribute to standardisation. Interoperability for data sharing should be addressed.
- Present a strategy for skills development, associating social partners where relevant, integrating SSH aspects and including relevant tools such as MOOCs (massive open online courses).
- Build on or seek collaboration with existing projects or solutions and develop synergies with other relevant European, national or regional initiatives, funding programmes and platforms, such as the New European Bauhaus.
- Seek to integrate insights from social sciences and humanities to maximise economic and social impact, including considering how workers carry out tasks and respond to safety issues.