

Processes4Planet Projects 2023



PROCESSES4PLANET

HORIZON-CL4-2023-TWIN-
TRANSITION-01-31: Energy
Efficiency & Climate Neutrality

Energy efficiency breakthroughs
in the process industries

THREE PROJECTS WERE FUNDED:

METAWAVE

ELOXYCHEM

SteamDry

CALL HORIZON-CL4-2023-TWIN-TRANSITION-01-31

TOPIC TITLE: ENERGY EFFICIENCY BREAKTHROUGHS IN THE PROCESS INDUSTRIES

SCOPE

To decarbonise the energy-intensive industries, both the availability of affordable renewable energy and the increase in 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 reduce this energy demand further. 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.

This call on the Twin Green and Digital Transition was for Research and Innovation

Actions (RIAs). It was a single-stage call which opened on 8 December 2022 with a deadline for applications of 20 April 2023.

CALL BUDGET

EUR 32 000 000

PROCESSES4PLANET THEMES AND GOALS		Energy-efficient and climate-neutral process industries		
		HORIZON-CL4-2023-TWIN-TRANSITION-01-31		
Theme	Goals	ELOXYCHEM	METAWAVE	SteamDry
Climate neutrality	Develop new electrified processes and energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies	✓	✓	✓
Circularity	Seed H4C's to foster circularity within/beyond process industries		✓	
Leadership in climate-neutral and circular solutions	Foster new skills/jobs/business dev, SMEs		✓	



AIM

METAWAVE's specific objectives include the development of advanced and modular microwave-based systems in high-temperature heating processes for three industrial sectors - ceramics, asphalt, and aluminium - as a replacement for fossil-based systems, the optimisation and energy-efficiency enhancement of the heating processes by integrating novel digital technologies, the integration of RES and energy flexibility measures in the systems through a virtual power plant, the deployment and validation of the heating systems, the demonstration of their techno-economic feasibility, and the demonstration of these systems in distinct industrial environments to help accelerate the approach to market readiness.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138476.



HIGH-TEMPERATURE HEATING PROCESSES WITH BREAKTHROUGH MICROWAVE AND DIGITAL TECHNOLOGIES FOR INCREASED ENERGY EFFICIENCY

CONCEPTS AND INNOVATIONS

Seven SMEs, along with six RTDs, two universities and three large enterprises are working together to develop several technological innovations that should reach TRL 6 by the project's end. These innovations are: Microwave plasma torch for porcelain tile firing; Direct-microwave heating with hot air flux for aggregate heating; Direct-microwave and induction heating for carbon anodes baking; Geopolymeric microwave refractories and secondary raw materials; Design and development of nanostructured additives for improved microwave absorption; Selection charts for the design of successful microwave processing and applicators; Multiparametric and multipoint Fiber Optic Sensor monitoring and control system; Thermography using SWIR multispectral cameras; VPP for hybrid centralised-distributed and autonomous energy flexibility; and Distributed process control systems. Other expected results of METAWAVE are detailed physics-based models of the novel microwave-heating processes and their corresponding Reduced Order Models (ROMs), data-driven optimisation models of the heating process, an Energy Management System and a Decision Support Tool with a user-friendly interface, and an increase in process energy efficiency with multi-criteria optimisation. The project implementation will take place in three phases: a consolidation and design phase, a development and prototyping phase, and a validation and demonstration phase.

WWW.ASPIRE2050.EU/METAWAVE.EU

RELEVANT FIELDS OF INNOVATION

- Integration of renewable heat and electricity
- Electricity-based heating technologies
- Breakthrough efficiency improvement
- Upgrading secondary resources
- Development of Hubs for Circularity
- Digital process development and engineering
- Digital plant operation

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Seed Hubs4Circularity to foster circularity within and beyond process industries
- Drive the innovation portfolio to first-of-a-kind plant (or units) so as to derisk investment (CAPEX/OPEX reduction, competitiveness)
- Foster new framework conditions to generate a market for climate-neutral and circular solutions
- Foster new skills and types of jobs and business development, including SMEs

COORDINATOR CONTACTS

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AIM

ELOXYCHEM aims to replace existing chemical processes by developing a new electrochemical conversion platform and drop-in technology. ELOXYCHEM uses renewable industrial feedstocks, as well as waste streams from conventional thermochemical chemicals production, eliminating the current dependence on fossil-derived feedstocks. The main output will be a first-of-a-kind pilot plant to be used in an industrial environment. As an output of the process, (di)Carboxylic acids with several commercial applications will be produced, including coating additives, catalysts, fine chemicals, agrochemicals, surfactants, fragrances, dyes, polymers for coatings, filaments and engineering materials.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138376.



CONCEPTS AND INNOVATIONS

Within the ELOXYCHEM project, three classes of electrochemical oxidation processes will be developed. The ELOXYCHEM team will concentrate initially on the development and optimisation work on the transformation of one specific cyclic alkene, which will be converted to an industry-relevant dicarboxylic acid. This diacid is used by the polymer industry for the production of high-performance polymers which are used in a wide range of applications for diverse markets from automotive industry to consumer goods (e. g., sportswear). ELOXYCHEM will also optimise the process to demonstrate the versatility of the process to multiple feedstocks, ranging from current feedstocks and future bio-based and biogenic sources. Using AI strategies for optimisation, the pilot plant will target improved electrochemical performance, improved lifetime and reduce cost. It will work to prove the viability of integrating with renewable energy sources, considering intermittency and the potential to offer demand-response flexibility. Work will look to integrate process design, including materials, reactor/cell, and separation methods, from process intensification and cost perspectives.

WWW.ELOXYCHEM-HORIZON.EU

RELEVANT FIELDS OF INNOVATION

- Integration of renewable heat and electricity
- Flexibility and demand response
- Electrochemical conversion
- Breakthrough efficiency improvement
- Innovative materials of the process industries
- Digital process development and engineering
- Digital plant operation

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Drive the innovation portfolio to first-of-a-kind plants (or units) in order to derisk investment (CAPEX/OPEX reduction, competitiveness)

COORDINATOR CONTACTS

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AIM

The EU-funded SteamDry project aims to advance steam drying technology (SSD) to enhance energy efficiency and support CO₂ emission-free processes. Its primary objective is to reduce energy consumption by 60 % during drying and 40 % across the entire production line for materials such as paper, board, tissue, and non-wovens. The SSD technology is designed to be adaptable to both new and existing machines, offering low capital and operating costs. By electrifying the drying process, SteamDry not only provides significant cost savings for users but also facilitates a transition towards greener manufacturing practices and reduces CO₂ emissions.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101137906.



CONCEPTS AND INNOVATIONS

The project will achieve its objectives by integrating several key advancements. This involves separating gas phases (air and steam), cleaning superheated steam from bio-based particles, and ensuring safe operation. An AI-supported advanced control platform will enhance process efficiency and safety. The proposed solution is versatile, allowing installation on both existing and new machinery with minimal capital and operating expenses, which will attract technology suppliers and offer substantial savings for users. The technology's adaptability extends beyond the pulp and paper industry, potentially benefiting sectors such as chemicals and wood processing. The consortium, composed of four R&D institutes, two universities, two leading technology suppliers, and five product manufacturers, brings together expertise in piloting, upscaling, AI, and modelling. This collaboration will validate the technology's potential and drive its successful market implementation, ultimately supporting EU CO₂ savings targets and fostering industry growth.

WWW.STEAMDRY.EU

RELEVANT FIELDS OF INNOVATION

- Advanced heat reuse
- Electricity-based heating technologies
- Breakthrough efficiency improvement
- Digital process development and engineering

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery
- Drive the innovation portfolio to first-of-a-kind plants (or units) in order to derisk investment (CAPEX/OPEX reduction, competitiveness).

COORDINATOR CONTACTS

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HORIZON-CL4-2023-TWIN-
TRANSITION-01-33: Energy
Efficiency & Climate Neutrality

Electrification of high temperature
heating systems

THREE PROJECTS WERE FUNDED:

ELECTRA

Elithe

CITADEL

CALL HORIZON-CL4-2023-TWIN-TRANSITION-01-33: ELECTRIFICATION OF HIGH TEMPERATURE HEATING SYSTEMS

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. This call on the Twin Green and digital Transition was for Innovation Actions (IAs). It was a single-stage call which opened on 8 December 2022 with a deadline for applications of 20 April 2023.

CALL BUDGET

EUR 35 670 000

PROCESSES4PLANET THEMES AND GOALS		Energy-efficient and climate-neutral process industries		
		HORIZON-CL4-2023-TWIN-TRANSITION-01-33		
Theme	Goals	ELECTRA	ELITHE	CITADEL
Climate neutrality	Develop new electrified processes and energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies	✓	✓	✓
	Replace fossil fuels and feedstock with renewable H2 and biomass in processes		✓	
Circularity				
Leadership in climate-neutral and circular solutions				



AIM

In ELECTRA, the hard-to-abate CO₂ emissions of the process industries are tackled with flexible electrification and CO₂ capture. New electrified manufacturing technologies for the cement, lime, and pulp industries will be developed, to drastically reduce GHG emissions in the EU, by substituting fossil fuels with renewable electrical energy, enabling the efficient capture and use or removal of an undiluted CO₂ stream from the decomposition of the raw material (calcium carbonate), and flexible power loads enabling a higher share of renewable electricity production in the electricity grid.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138392.



CONCEPTS AND INNOVATIONS

ELECTRA will develop and validate an emission-free, electrically heated cement, lime, and lime mud production process at MW scale capable of reaching temperatures up to 2000 °C. By using low-emission electricity instead of combustion for decomposing calcium carbonate and capturing the carbon dioxide produced, it is possible to run plants with close to zero carbon dioxide emissions, providing even negative-emission products for society. Scalability and replicability are showcased by platform-based solutions offering modularity and the possibility to run in various hybrid modes during a transition period, lowering initial CAPEX. These solutions will allow for both new electric installations and the revamping of old ones. Different applications require different properties for the product, so variations of electrically heated processes will be developed to support and complement MW scale demonstration. Replacing combustion processes with electricity-based solutions and significantly increasing emission-free electricity production is an effective means of mitigating climate change. Cement, as one of the ingredients for concrete, is the world's most used building material and the largest CO₂ emitter of all industrial sectors. ELECTRA combines world-leading industry in the cement, lime, and pulp sectors, the

main technology manufacturers, electric technology providers, and leading research institutions in industrial electrification and material sciences.

RELEVANT FIELDS OF INNOVATION

- Integration of renewable heat and electricity
- Flexibility and demand response
- Electricity-based heating technologies

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Develop new efficient CO/C02 Capture and purification technologies
- Drive the innovation portfolio to first-of-a-kind plants (or units) in order to derisk investment (CAPEX/OPEX reduction, competitiveness)

COORDINATOR CONTACTS

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AIM

The main objective of eLITHE is to develop new electrified heating systems for high temperature (>1,000 °C) processes from the ceramic industries sector: the melting of ceramic frits, calcination of alumina, and firing of bricks. The technology to be deployed in each process has been determined based on the most promising ones to have an impact in the short term. The technologies will enable up to 100 % heating from electricity. The new processes synergise well with the use of hydrogen as fuel. Thus, GHG emissions will be reduced in a similar amount at the process level.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138325.



CONCEPTS AND INNOVATIONS

The systems combine several advanced electrification technologies: induction and electrodes for melting; microwaves for calcination; radiant walls and hybrid heating for bricks. The heating processes are modelled using Computational Fluid Dynamic that will be the basis for the development of their Digital Twin. Simulation will support the design, scaling-up and integration of the new electric solutions. Flexibility and circularity are increased by assessing the integration of high-temperature thermal energy storage systems using solid media. eLITHE will investigate the feasibility and performance of waste materials coming from the value chains involved in the project. Digitalisation of the industries is improved in several respects through implementing digital monitoring consisting of thermal and visible cameras to extract information using AI algorithms, including the temperature, volume, quality, and feedstock load rates, and by the development of a digital platform for monitoring, control and simulation of the processes. This solution will comprise tools for real-time simulation using digital twins, will allow gathering data from new sensors, computation of KPIs and OPEX or implement energy efficiency by collecting the price of different sources.

RELEVANT FIELDS OF INNOVATION

- Hybrid fuel transition technologies
- Electricity-based heating technologies
- Using hydrogen in industrial processes
- Innovative materials of the process industries
- Inherent recyclability of materials
- Upgrading secondary resources
- Digital process development and engineering
- Digital plant operation
- Intelligent material and equipment monitoring

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Foster new framework conditions to generate a market for climate-neutral and circular solutions

COORDINATOR CONTACTS

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WWW.ELITHE.EU



AIM

The aim of the CITADEL project is to substitute fossil combustion processes with innovative electric technologies, such as electric resistance heating, microwave heating and plasma heating. This transformation will result in a drastic reduction of CO₂ emissions. Five demonstration cases (refractory firebricks, glass production, steel making, concrete recycling, and copper wire production) covering a wide range of high temperature heating systems in different fields of process industries will be investigated and serve to demonstrate the use of advanced electric heating technologies in different temperature ranges over 400 °C. Scalability and cost efficiency will be demonstrated for each of the proposed technologies.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138794



CONCEPTS AND INNOVATIONS

The integration of highly efficient electrical heating technologies into the five use cases requires the development of new engineering design concepts. Demonstrators will be implemented on pilot-plant scale for each of the considered use cases by scaling up from TRL 5 to TRL 7. For each demonstration case, numerical and hybrid models are applied combining machine learning with first-principles physical modelling (fusion of data with physics) to determine optimal processing conditions (GHG reduction of at least 30 % at similar or lower cost and achieving stretched targets at optimal setpoints) and to achieve an efficient and flexible process control (e.g. pulsation) by lower temperature gradients, more homogeneous temperature distribution and more accurate and immediate temperature adjustment. The full potential of renewable energy will be unlocked by simulating interoperability with the grid, green energy systems (renewable power generation: wind, solar) and energy storage (electric batteries or high-temperature thermal storage) and demonstrating the techno-economic benefits at pilot scale to reduce OPEX by at least 25 % compared to the baseline scenario through interactions with grid operators. For evaluating the

proposed technologies' capabilities for improving grid integration and economic performance, a methodology to properly evaluate flexibility possibilities in process industries will be produced.

RELEVANT FIELDS OF INNOVATION

- Integration of renewable heat and electricity
- Flexibility and demand response
- Electricity-based heating technologies

P4PLANET LONG-TERM IMPACTS

- Develop new electrified processes and Energy efficiency, ensuring process flexibility and capturing the full potential of renewable energies
- Drive the innovation portfolio to first-of-a-kind plants (or units) in order to derisk investment (CAPEX/OPEX reduction, competitiveness)

COORDINATOR CONTACTS

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WWW.CITADEL-HORIZON.EU

HORIZON-CL4-2023-TWIN-
TRANSITION-01-36: Energy
Efficiency & Climate Neutrality

Modelling process industry
transition to climate neutrality,
sustainability and circularity

TWO PROJECTS WERE FUNDED:

AMIGDALA

TRANSCIENCE

CALL HORIZON-CL4-2023-TWIN-TRANSITION-01-36: MODELLING PROCESS INDUSTRY TRANSITION TO CLIMATE NEUTRALITY, SUSTAINABILITY AND CIRCULARITY

SCOPE

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 in 1990 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 the 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 have 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. This call on the Twin Green and Digital Transition was for Research and Innovation Actions (RIAs). It was a single-stage call which opened on 8 December 2022 with a deadline for application of 20 April 2023.

CALL BUDGET

EUR 13 000 000

PROCESSES4PLANET THEMES AND GOALS		Energy-efficient and climate-neutral process industries	
		HORIZON-CL4-2023-TWIN-TRANSITION-01-36	
Theme	Goals	TRANSIENCE	AMIGDALA
Climate neutrality			
Circularity			
Leadership in climate-neutral and circular solutions	Foster new framework conditions to generate a market for climate-neutral and circular solutions	✓	✓



AIM

AMIGDALA aims to support government and industry in defining and evaluating pathways for circular, climate-neutral, and competitive industries. It develops an integrated modelling approach for the EU's energy-intensive sectors, addressing standardisation gaps in model integration. By providing consistent, validated data aligned with Green Deal sustainability goals, it ensures transparency and a better understanding between model outcomes and decision-makers' needs. All in all, AMIGDALA enhances decision-making for a sustainable, carbon-neutral future.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138534.



CONCEPTS AND INNOVATIONS

AMIGDALA will achieve its objectives by developing an integrated modelling approach specifically for the EU's energy-intensive sectors, addressing the lack of standardisation in model integration. The project will utilise new and improved technologies, such as advanced data analytics, machine learning, and sector-specific modelling tools to create consistent, validated datasets. These will support policymakers in making evidence-based decisions aligned with Green Deal objectives. The consortium brings together a diverse group of experts, including academic institutions, industry leaders, and policymakers, combining technical knowledge with practical industry insights. This collaboration ensures that models and data reflect real-world conditions and are adaptable to changing economic and policy environments. AMIGDALA will enhance transparency by creating open-access platforms, allowing stakeholders to visualise and interact with the data and model outcomes. The project will also develop user-friendly interfaces and tools that bridge the gap between complex model outputs and the needs of decision-makers, fostering better understanding and informed decisions. By focusing on

circularity and climate neutrality, AMIGDALA aims to drive the market uptake of transformative solutions for a sustainable, carbon-neutral future.

RELEVANT FIELDS OF INNOVATION

- Integrating circular carbon into energy applications
- Flexibility and demand response
- Digital process development and engineering
- Intelligent material and equipment monitoring

P4PLANET LONG-TERM IMPACTS

- New framework conditions to generate a market for climate-neutral and circular solutions

COORDINATOR CONTACTS

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WWW.AMIGDALAPROJECT.EU



AIM

The TRANSIENCE project aims to promote the co-production of knowledge in sustainability science, policy, and industry decision-making by creating an open and transparent model ecosystem (MIC3) to assess industrial circularity, decarbonisation, and sustainability in the EU as well as in heterogeneous European industrial clusters. It seeks to investigate the interplays between these three dimensions by enhancing existing and/or developing new scientific model capabilities. The project will ensure transparency through open science, engage stakeholders adopting a co-development approach, promote best practices, and build relevant technical capacity in academia, emissions-intensive industries, and four regional clusters, thereby driving and de-risking industrial innovation.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101137606.



CONCEPTS AND INNOVATIONS

TRANSIENCE will create an open, integrated, modular framework to simulate pathways toward achieving the transition of European industries to climate neutrality while fully integrating material efficiency and circular economy measures: the Model for European Industry Circularity and Climate Change mitigation (MIC3). To do this, it will bring together the consortium's high-level expertise behind, and backbones of, well-established models in actively informing climate, energy, and industrial policies in Europe addressing concerns related to broader sustainability, such as environmental synergies and trade-offs, changes in industrial output, employment, competitiveness, global sourcing, trade, and other macroeconomic indicators. This will allow establishing the required capacities and providing useful insights for industrial circularity performance, decarbonisation, and sustainability. MIC3, the 'satellite' modules comprising it (OPEN-GEM for socioeconomics, OPEN-PROM for energy, EU-MFA and SIMSON for material flows, Premise for lifecycle assessment, and EDM-Invest and FORECAST-Industry for techno-economics) and the scenario exercises stemming from them will be entirely co-developed and validated with relevant stakeholders from industry, policy, and civil society, as well as used to inform assessments and transition strategies at the EU and country levels, at the global level, and within four heterogeneous regional industry clusters in Europe to ensure their usability and exploitation in real-world use cases.

RELEVANT FIELDS OF INNOVATION

- European Community of Practice (H4C)
- Development of Hubs for Circularity
- Human resources, skills, and labour market

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Seed Hubs4Circularity to foster circularity within and beyond process industries
- Drive the innovation portfolio to first-of-a-kind plant (or unit) to derisk investment (CAPEX/OPEX reduction, competitiveness)
- Foster new framework conditions to generate a market for climate-neutral and circular solutions
- Foster new skills and types of jobs and business development, including SMEs

COORDINATOR CONTACTS

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WWW.TRANSIENCE.EU

HORIZON-CL4-2023-TWIN-
TRANSITION-01-37 / H4C call:
Circularity and zero pollution

Hubs for circularity for near zero
emissions regions applying industrial
symbiosis and cooperative approach to
heavy industrialized clusters and su-
rrounding ecosystems

TWO PROJECTS WERE FUNDED:

HURRICANE

IS2H4C

CALL 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

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 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-sectoral cooperation can trigger the green transition by sharing

resources and infrastructure investments.

This call on the Twin Green and Digital Transition was for Innovation Actions (IAs). It was a single-stage call, which opened on 8 December 2022 with a deadline for application of 20 April 2023

CALL BUDGET

EUR 40 000 000

PROCESSES4PLANET THEMES AND GOALS		Circularity and Zero Pollution in Process Industries	
		HORIZON-CL4-2023-TWIN-TRANSITION-01-37 / H4C call	
Theme	Goals	HURRICANE	IS2H4C
Climate neutrality			
Circularity	Design processes for maximum resource efficiency, including the development of materials for circularity	✓	✓
	Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes		✓
	Develop new processes to ensure full valorisation of waste water, recycled water, energy and solutes recovery	✓	✓
	Seed H4C's to foster circularity within and beyond process industries	✓	✓
Leadership in climate-neutral and circular solutions			



AIM

Creating a sector-coupling circular hub centred around the ArcelorMittal Ghent site and targeting efficient resource management together with the recovery and utilisation of squandered industrial waste heat and water. The project targets a 20 % reduction in energy, water, and raw material consumption, along with significant cuts in greenhouse gas emissions, contributing to environmental sustainability and industry transition goals.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138494.



CONCEPTS AND INNOVATIONS

A pioneering sector-coupling circular hub will be established at the ArcelorMittal Ghent site, serving as a model for interconnected industrial processes that promote collaboration and resource efficiency. This will be supported by efficient resource management strategies, which will focus on recovering and utilising industrial waste heat and water from steel production. The aim is to minimise waste and enhance circularity within the steel industry.

The benefits of the circular hub will extend beyond industry through the implementation of a heat grid, positively impacting other sectors and local communities. To optimise and replicate the circular hub model, integrated software tools will be introduced within the HURRICANE project, improving efficiency and streamlining processes. A robust user engagement strategy will also be developed, involving industrial stakeholders and local communities to ensure the project aligns with their needs and fosters collaboration. Additionally, the project will align with the EU Green Deal and "Fit for 55" package, increasing public awareness and advancing sustainability across the European industrial landscape.

RELEVANT FIELDS OF INNOVATION

- Resource-efficient processes and materials for circularity
- Development of Hubs for Circularity (H4Cs)

P4PLANET LONG-TERM IMPACTS

- CO₂ reduction through energy efficiency or renewable energy

COORDINATOR CONTACTS

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WWW.HURRICANE-HUB.EU



AIM

The project will deploy and demonstrate near-commercial-scale industrial symbiosis through innovative technologies to ensure the resilience and sustainability of Hubs for Circularity (H4Cs), considering planet, people, and profit. The project aims to facilitate the market penetration of H4C through novel financial schemes and social innovation approaches, unlocking public and private investment, and developing a digital H4C collaboration platform for information-sharing and smart decision-support. IS2H4C will look to achieve a standardised top-down H4C design methodology that will be applicable as a reference regional development model to maximise wider uptake of IS2H4C's results during and after the project's execution. The project aspires to become a reference for promoting H4C as Europe's future sustainable regional development model.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138473



CONCEPTS AND INNOVATIONS

Along with conventional Industrial Symbiosis (IS) achieved through the exchange of materials, water, and energy, IS2H4C will promote infrastructure-, service-, and carbon-based IS to transform existing industrial areas into Industrial Symbiosis Networks (ISNs). These ISNs will be integrated with surrounding rural and/or urban ecosystems to form physical H4Cs. The development of physical H4C will be facilitated by a digital collaboration platform (DigitalH4C). DigitalH4C fosters the bottom-up emergence of ISNs by real-time resource monitoring and tracking, dynamic supply-demand matchmaking, efficient and secure information-sharing, and transparent marketplace trading. It also performs effective evaluation of top-down coordination strategies based on a multi-dimensional approach combining attributional and consequential Life Cycle Assessment (LCA). IS2H4C will demonstrate four first-of-a-kind hubs with business cases and exploitation strategies in the Netherlands, Germany, Spain, and Turkey, populated by a range of industries. Cutting-edge green technologies will be deployed and demonstrated to realise IS in demo hubs, including wind and solar power generation, electrolysis for hydrogen, carbon capture and utilisation, waste heat capture and distribution, hydrogen use in built environment, and oxycombustion. The technology innovation and integration will improve industrial performance and boost socioeconomic wellbeing in the surrounding ecosystems. IS2H4C is a real-life demonstrator of H4C at scale and will establish best IS practices towards a climate-neutral, circular, and digitised future.

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WWW.IS2H4C-PROJECT.EU

RELEVANT FIELDS OF INNOVATION

- Integrating circular carbon into energy applications
- Alternative hydrogen production routes
- Using hydrogen in industrial processes
- Flexible CO₂ capture and purification technologies
- Innovative materials of the process industries
- Upgrading secondary resources
- Wastewater valorisation
- Demonstration of Industrial-Urban Symbiosis
- European Community of Practice (H4C)
- Development of Hubs for Circularity
- Intelligent material and equipment monitoring
- Digitalisation of industrial-urban symbiosis
- Human resources, skills, and labour market

P4PLANET LONG-TERM IMPACTS

- Replace fossil fuels and feedstock with renewable H₂ and biomass in processes
- Develop new efficient CO/CO₂ Capture and purification technologies
- Develop efficient CO₂ valorisation routes to chemicals, minerals and fuels
- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery
- Seed Hubs4Circularity to foster circularity within and beyond process industries
- Foster new framework conditions to generate a market for climate-neutral and circular solutions
- Foster new skills and types of jobs and business development, including SMEs

HORIZON-CL4-2023-TWIN- TRANSITION-01-40: Circularity and zero pollution

Sustainable and efficient industrial water consumption: through energy and solute recovery

THREE PROJECTS WERE FUNDED:

R3VOLUTION

RESURGENCE

CORNERSTONE

CALL HORIZON-CL4-2023-TWIN-TRANSITION-01-40: SUSTAINABLE AND EFFICIENT INDUSTRIAL WATER CONSUMPTION: THROUGH ENERGY AND SOLUTE RECOVERY

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.

This call on the Twin Green and Digital Transition was for Research and Innovation Actions (RIAs). It was a single-stage call which opened on 8 December 2022, with a deadline for application of 20 April 2023.

CALL BUDGET

EUR 30 000 000

PROCESSES4PLANET THEMES AND GOALS		Circularity and Zero Pollution in Process Industries		
		HORIZON-CL4-2023-TWIN-TRANSITION-01-40		
Theme	Goals	R3VOLUTION	RESURGENCE	CORNERSTONE
Climate neutrality				
Circularity	Design processes for maximum resource efficiency, including the development of materials for circularity	✓	✓	✓
	Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery	✓	✓	✓
Leadership in climate-neutral and circular solutions				



AIM

The R3VOLUTION (R3V) project aims to transform industrial water management in the EU by enabling over 90 % water reuse, 45 % solute recovery, 50 % waste heat reuse, and eliminating hazardous substances. R3V will develop membrane-based treatment systems and a digital process assistant (DPA) to optimise configurations for different industries, reducing risks and enhancing efficiency. Demonstrations will be conducted at pilot scale in the petrochemical, bio-based chemical, pulp & paper, and steel industries, with potential for replication in other sectors.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138245



The project focuses on water reclamation, energy recovery, and promoting sustainable practices across various industrial sectors.

CONCEPTS AND INNOVATIONS

The R3VOLUTION project will achieve its objectives by developing innovative membrane-based treatment systems that enable high levels of water reuse (>90 %), solute recovery (>45 %), and waste heat reuse (>50 %), while eliminating hazardous substances. These treatment systems combine advanced nanocellulose and ceramic membranes, which offer enhanced filtration performance, selectivity, and resistance. In addition, the project integrates waste heat recovery to improve energy efficiency. A key element of R3V's approach is the Digital Process Assistant (DPA), a digital tool that leverages machine learning, process optimisation, and Explainable AI (XAI) to support system design, minimise operational risks, and optimise resource recovery across various industries. The consortium's strengths play a crucial role in achieving these goals. Technological partners with expertise in membrane development, energy recovery, and digitalisation ensure the success of technology innovations. The inclusion of industry leaders in the four target sectors allows for real-

world application and demonstration of these solutions in petrochemical, pulp & paper, and steel industries. By demonstrating the system at pilot scale and assessing its transferability to other industries, the project ensures scalability and broad replicability for its innovative solutions.

RELEVANT FIELDS OF INNOVATION

- Advanced heat reuse
- Wastewater valorisation
- Development of Hubs for Circularity
- Digital process development and engineering

P4PLANET LONG-TERM IMPACTS

- Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery
- Seed Hubs4Circularity to foster circularity within and beyond process industries

COORDINATOR CONTACTS

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WWW.R3VOLUTION.EU



AIM

RESURGENCE aims to transform EU process industries into Wastewater Resource Recovery Facilities to support the EU's 2050 goals of climate neutrality, circularity, and competitiveness. The project will develop a comprehensive portfolio of modular and flexible treatments, alongside digital technologies, to maximise water and energy recovery and increase Industrial Wastewater valorisation. RESURGENCE addresses several sectors (paper, chemical, steel, and urban-industrial symbiosis) to demonstrate its concept's versatility and deploy advanced technologies for water circularity, energy and feedstock recovery and innovative digital tools, including a decision support tool (DST), AI-based tools, and Digital Twins, to optimise water and energy efficiency.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138097



CONCEPTS AND INNOVATIONS

RESURGENCE, currently in its initial stage with experimental work at lab-scale, will implement four case studies in three industrial sectors (Pulp & Paper with Navigator in Portugal, Chemicals with Organik Kimya in Türkiye, and Steel with Celsa in Poland) as well as a fourth study exploring synergies between urban and industry wastewater treatment with AQUALIA in Spain. The main impact foreseen for the project is the establishment, in these four sites of seeds of future hubs for circularity, thus contributing to achieving the zero pollution and zero waste targets of the EU in process industries. By integrating green and digital solutions, RESURGENCE seeks to recover water, energy (heat, biogas, hydrogen, electricity), and various valuable feedstocks, contributing to near-zero liquid and Waste Discharge (ZLWD). The project's technologies will be cross-sectoral, modular, and easily integrable with existing systems, ensuring broad applicability and delivering significant environmental, social, and economic benefits. RESURGENCE will be validated at lab and pilot scales in case studies across the three industrial sectors and the urban-industrial symbiosis case study. The project will also promote industrial symbiosis through Seeds for Circularity (S4C), advancing Hubs for Circularity (H4C) and establishing new circular value chains.

RELEVANT FIELDS OF INNOVATION

- Integration of renewable heat and electricity
- Advanced heat reuse
- Alternative hydrogen production routes
- Upgrading secondary resources
- Wastewater valorisation
- Demonstration of Industrial-Urban Symbiosis
- Development of Hubs for Circularity
- Digital process development and engineering
- Digital plant operation
- Digitalisation of industrial-urban symbiosis

P4PLANET LONG-TERM IMPACTS

- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery
- Seed Hubs4Circularity to foster circularity within and beyond process industries

COORDINATOR CONTACTS

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AIM

The CORNERSTONE project integrates novel technologies and digital developments into industrial wastewater treatment systems for the recovery and recycling of freshwater, energy and solutes. The specific objectives of CORNERSTONE are to: test, advance and optimise novel water treatment modules in laboratory; test, advance and optimise smart monitoring tools for digitalisation and intensification of industrial processes; integrate and validate the CORNERSTONE system configurations in three demonstration sites (steel, pulp and paper and chemical industry); quantify CORNERSTONE's solutions in terms of their sustainability in the environmental, economic and social dimensions; and develop decision support tools for digitally enabled industrial water, energy and resources stewardship.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138504.



CONCEPTS AND INNOVATIONS

CORNERSTONE will develop and demonstrate innovative, digitalised wastewater treatment systems for three strategic applications (pulp and paper, steel and chemical industries). In CORNERSTONE, six different technologies have been selected for their potential in thermal and chemical energy recovery (heat exchangers and anaerobic membrane bioreactors), water recovery (nanofiltration and membrane distillation), and solute recovery (electrodialysis and membrane crystallisation). Simultaneously, sensors and smart monitoring techniques will be integrated to optimise process operations, considering factors such as energy efficiency, water quality, and cleaning cycles, etc. A key innovation is deploying the CORNERSTONE systems at demonstration sites, serving as lighthouse projects to guide the industry towards the widespread adoption of efficient water technologies. This approach will be further validated through life-cycle assessments, and at the same time providing industries with the best decision support tools for improved water, energy, and solute management. Sixteen partners from eight European member states form a multidisciplinary consortium, which includes large enterprises, academia and research and technology organisations. Targeting steel, pulp & paper, and chemical industries, CORNERSTONE aligns with P4Planet's objectives, paving the way for circular processes and EU climate neutrality by 2050.

RELEVANT FIELDS OF INNOVATION

- Wastewater valorisation
- European Community of Practice (H4C)
- Digital process development and engineering
- Digital plant operation
- Intelligent material and equipment monitoring

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes to ensure full valorisation of wastewater, recycled water, energy and solutes recovery
- Drive the innovation portfolio to first-of-a-kind plants (or units) in order to derisk investment (CAPEX/OPEX reduction, competitiveness)
- Foster new framework conditions to generate a market for climate-neutral and circular solutions

COORDINATOR CONTACTS

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HORIZON-CL4-2023-TWIN-
TRANSITION-01-42: Circularity and
zero pollution

Circular economy in process industries: Upcycling large volumes of secondary resources

FIVE PROJECTS WERE FUNDED:

RecAL

PESCO-UP

CORNERSTONE

W2W

ICARUS

CIRCULess

CALL HORIZON-CL4-2023-TWIN-TRANSITION-01-42: CIRCULAR ECONOMY IN PROCESS INDUSTRIES: UPCYCLING LARGE VOLUMES OF SECONDARY RESOURCES

SCOPE

Currently, only 12% of the material resources used in the European process industry are recycled and recovered materials, and these are mostly downcycled 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-sectoral elements are important and deserve due attention.

This call on the Twin Green and Digital Transition was for Research and Innovation Actions (RIAs). It was a single-stage call, which opened on 8 December 2022 with a deadline for applications of 20 April 2023.

CALL BUDGET

EUR 30 000 000

PROCESSES4PLANET THEMES AND GOALS		Circularity and Zero Pollution in Process Industries					
		HORIZON-CL4-2023-TWIN-TRANSITION-01-42					
Theme	Goals	RecAL	PESCO-UP	W2W	ICARUS	CIRCULess	NEO-CYCLE
Climate neutrality							
Circularity	Design processes for maximum resource efficiency, including the development of materials for circularity	✓	✓	✓	✓	✓	✓
	Develop new processes for the circularity of secondary materials from wastes/residues for all industrial processes	✓	✓	✓	✓	✓	✓
	Seed H4C's to foster circularity within and beyond process industries	✓					
Leadership in climate-neutral and circular solutions	Foster new framework conditions to generate a market for climate-neutral and circular solutions	✓	✓	✓		✓	✓
	Foster new skills and types of jobs and business development, including SMEs, through P4Planet programs and H4Cs			✓		✓	✓



AIM

Recycling aluminium uses a mere 5 % of the energy required for the primary production of aluminium. RecAL aims to maximise the potential of this resource. A consortium of 19 European partners will advance 14 Circular Amplification Technologies (CATs) up to TRL 6 and integrate them into a digital, socio-technical ecosystem - the RecAL HUB - enabling direct collaboration of all stakeholders while closing resource and data loops at regional and European scales. RecAL's innovations target a variety of goals, such as improvements to capture, separate, and enable circular reuse of aluminium recyclates and the development of sustainable, recycling-friendly alloys.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138747



CONCEPTS AND INNOVATIONS

RecAL has a set of four specific objectives, which are implemented through technical Work Package Clusters (WPCs). These are to develop, validate and demonstrate a digital circularity platform for the entire aluminium recycling value chain both within and between individual company production lines; enable leaps in scrap purity by advanced sorting and refining technologies for EoL aluminium and full circularity of process by-products split into three sub-clusters; maximise the impurity tolerance of next-generation alloy designs in high-volume and high-impact industries; and provide paradigm shifts along the aluminium processing value chain, fostering FAIR data architectures and accelerating technology uptake and transparent value chains. These four work clusters provide the envelope for 14 Circular Amplification Technologies (CATs), advanced recycling technologies that are currently at TRL 4 and will be further developed towards TRL 5-6 to improve sustainability and advance circularity in the metal processing and manufacturing industry. Linkage between the WPCs will be performed continuously during the project and will be showcased by three use case demonstrations, connecting multiple CATs via the RecAL HUB for Circular Aluminium.

RELEVANT FIELDS OF INNOVATION

- Flexibility and demand response
- Innovative materials of the process industries
- Inherent recyclability of materials
- Upgrading secondary resources
- Development of Hubs for Circularity
- Digital process development and engineering
- Intelligent material and equipment monitoring

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Seed Hubs4Circularity to foster circularity within and beyond process industries
- Foster new framework conditions to generate a market for climate-neutral and circular solutions

COORDINATOR CONTACTS

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AIM

PESCO-UP will develop processes for upcycling cotton/polyester textile waste into cotton and polyester products (textiles, films, and composites) to achieve high material processing efficiency and considerable reduction in CO₂ emissions associated with textile production and waste management. It will develop digital and data-sharing tools to enhance the effectiveness of processes in the recycling value chain. In addition, PESCO-UP aims to upskill the workforce through targeted training, ensuring that new technologies enhance job appeal and contribute to a skilled workforce, with a focus on digital competencies. Identification of regulatory and socio-economic barriers and enablers will be contributed by policy briefs and events.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138367



CONCEPTS AND INNOVATIONS

PESCO-UP aims to achieve several key results that significantly advance current knowledge and practices in textile recycling. Digital material passports, comprising data required throughout the value chain and the marketplace-style dataspace for sharing data describing material streams, support better matching of supply and demand and will optimise recycling performance. The developed imaging technologies utilising NIR/MIR spectroscopy will improve the accuracy and efficiency of sorting and processing textile materials, leading to better separation of different types of fibres and impurities throughout the processing. Purification and separation of cotton and polyester into their own fractions will make recycled materials more comparable to virgin materials in terms of quality and usability. The developed methods for wet-spinning and melt spinning of textile fibres, producing cellulose films, and creating composites from recycled materials will open new markets and applications for recycled textiles, promoting a circular economy. The project will conduct pilot demonstrations of the developed technologies to validate the scalability and efficiency of the technologies. Detailed assessments will be conducted to evaluate the economic viability, sustainability, and provide market analysis. PESCO-UP has

resumed technical collaboration among members of the previous ECOSYSTEX project and uses its communications platforms to disseminate results.

RELEVANT FIELDS OF INNOVATION

- Inherent recyclability of materials
- Upgrading secondary resources
- Development of Hubs for Circularity
- Intelligent material and equipment monitoring
- Human resources, skills, and labour market

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Foster new framework conditions to generate a market for climate-neutral and circular solutions
- Foster new skills and types of jobs and business development, including SMEs

COORDINATOR CONTACTS

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AIM

The W2W project seeks to create and evaluate a comprehensive framework for multidimensional cascade valorisation of wood from construction and demolition (C&D) and furniture waste. The initiative focuses on drastically decreasing the demand for virgin materials, cutting the amount of waste sent to landfill or incineration, and helping the transition to a circular economy, thereby fostering closed-loop systems where materials are continuously reused and recycled throughout their existence.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138789.



CONCEPTS AND INNOVATIONS

W2W proposes a comprehensive framework for multi-dimensional cascade valorisation of wood from C&D and furniture waste, consisting of four core components/pillars: Advanced Separation and Sorting Technologies; Upcycling Processes and Technologies; Digital Tools for Improving Circular Flows of Secondary Materials; and Supportive Frameworks in Policy, Market, and Skills. W2W will demonstrate efficient and sustainable value chains to produce wood without pollutants; biocomposite building materials; biopolymers; polyols; chemical detergents; and the recovery of nutrients, using technologies and tools that allow the selection of optimal cascade paths for further uses of wood products and their materials.

RELEVANT FIELDS OF INNOVATION

- Electrically driven separation
- Innovative materials of the process industries
- Inherent recyclability of materials
- Upgrading secondary resources
- Digital materials design

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Foster new framework conditions to generate a market for climate-neutral and circular solutions

COORDINATOR CONTACTS

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AIM

The ICARUS project aims to serve as a pivotal initiative for advancing the circular economy within Europe. By recovering and transforming waste into valuable resources, this project not only addresses the pressing environmental challenges of resource depletion and waste management but also fosters economic resilience and innovation. The pursuit of the integration of recovered construction materials into the market exemplifies a pragmatic approach to closing the loop, ensuring that secondary materials are reused, repurposed, and reintegrated into the economy, and thereby enhancing resource efficiency and fostering sustainable development across the EU.

DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138646



CONCEPTS AND INNOVATIONS

ICARUS represents a breakthrough in the research and demonstration of new technologies to upgrade Secondary Raw Materials (SRMs), ensuring similar quality as primary raw materials from three waste streams to improve circular economy principles in several intensive industries, with its implementation in the construction sector (Lithium Aluminosilicate Residue (LAR), Waste cellulose and Steelmaking slags), to improve circular economy principles in P4P industry sectors. ICARUS will achieve its main objectives through the three waste streams validated in demonstration cases. A full economic evaluation to demonstrate the economic feasibility of the proposed technologies will be developed. The main focus will be on the development of better separation and sorting techniques, digitalisation, ensuring consistent quality and safety of recycled materials, and their suitability for upcycling processes. In addition, logistic aspects such as production planning, risk assessment and management, and zero-defect at the supply chain level will be considered. The demonstration cases will present the innovative upcycling of SRMs through realistic use cases.

RELEVANT FIELDS OF INNOVATION

- Innovative materials of the process industries
- Upgrading secondary resources
- Wastewater valorisation
- Demonstration of Industrial-Urban Symbiosis
- European Community of Practice (H4C)
- Development of Hubs for Circularity
- Digitalisation of industrial-urban symbiosis

P4PLANET LONG-TERM IMPACTS

- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Seed Hubs4Circularity to foster circularity within and beyond process industries

COORDINATOR CONTACTS

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AIM

CIRCULESS will foster circularity in the construction and manufacturing process industries, by minimising Construction, Demolition and Manufacturing waste, with a focus on mineral and timber-based materials, by developing new processes for circularity, without compromising quality, and also sustainable-by-design circular products. The main objective of CIRCULESS will be addressed by experimenting with new circular products and processing techniques to improve the quality and performances of secondary materials up to industry standards and improve environmental friendliness. These actions will be supported by a tailored

digital platform for waste management, while recommendations for standards updates and relevant training material for both upskilling and training will be created.

CONCEPTS AND INNOVATIONS

The overall methodology of CIRCULESS concerns the development and demonstration of a cyber-physical approach to maximise circularity, by developing a unique Digital Platform for waste management. CIRCULESS will focus on Construction, Demolition and Manufacturing Wastes (CDMW). The output of the project will be a unique digital platform for circularity and upcycling, and it will develop in parallel relevant characterisation, sorting & logistic solutions. In addition, CIRCULESS will maximise impact by involving customer perception and marketability, reskilling & training and contribute to standardisation. Today, the construction and manufacturing sectors are segregated, with the first leveraging civil engineering and the second mechanical, and process industries for metal products, plastics, etc.

RELEVANT FIELDS OF INNOVATION

- Innovative materials of the process industries
- Inherent recyclability of materials
- Upgrading secondary resources
- Development of Hubs for Circularity
- Digital materials design
- Digital process development and engineering
- Human resources, skills, and labour market

P4PLANET LONG-TERM IMPACTS

- Design processes for maximum resource efficiency, including the development of materials for circularity
- Develop new processes for circularity of secondary materials from wastes/residues for all industrial processes
- Seed Hubs4Circularity to foster circularity within and beyond process industries
- Foster new framework conditions to generate a market for climate-neutral and circular solutions
- Foster new skills and types of jobs and business development, including SMEs

COORDINATOR CONTACTS

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DISCLAIMER

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138330



Testimonials



"The TERRA project was one of the first to explore new electrocatalytic solutions for process intensification. It greatly benefited from the possibility of sharing expertise and knowledge through the events organized within the SPIRE partnership and the long-term vision elaborated by the A.SPIRE association shared by all the companies and SMEs participating in the project."

Gabriele Centi
President, ERIC aisbl



"A.SPIRE helped us to promote the project outcomes through their wide variety of resources, including website, events or brochures. It facilitates the possibility of meeting other related projects and interacting with them. We are very grateful for the support of the partners of the association such as CEPI for their collaboration on contributing to disseminate the project."

Juan José Cepriá
Roads and Environment Research Group Manager,
ACCIONA Technology Centre



"During the FISSAC project our experience with the partnership has been very fruitful enabling the opportunity of collaboration to foster industrial symbiosis in different value chains and set up the foundations to build future opportunities after the project."

Blanca Juez Sánchez
R&D Project Manager, ACCIONA Construcción



"COMPASsCO₂ project would like to acknowledge A.SPIRE for setting up the framework needed to develop new materials at low TRL and with strong focus on performance improvement. We think that developing new components and materials for extreme operating conditions will enable concentrated solar power plants to be coupled to high temperature processes and contribute to the decarbonization of various industrial sectors. We also acknowledge the networking platforms offered by A.SPIRE."

Daniel Benitez
Project Engineer, DLR, Solar Research Institute



"Developing synergies with the alumina sector in Europe is at the core of the Reactiv project. We test and demonstrate how bauxite residue can be converted into an active material for producing a new low-carbon Supplementary Cementitious Materials (SCM). The P4Planet platform is very instrumental to enable such cross sectoral collaboration."

Philippe BENARD
Alternative SCM's R&D Project Manager,
HOLCIM Innovation Centre



"Thanks to A.SPIRE, we have been able to access European funds, technical resources, and dissemination networks that have driven the success of our project. I believe that SPIRE and P4Planet are key initiatives to drive the ecological transition and competitiveness of the European industry."

Álvaro Pecharrmán Ruiz
Project Manager Public Programmes Unit, CIRCE



"The CREAToR consortium greatly appreciated joining the SPIRE partnership. The various events organized by A.SPIRE significantly widened our outreach to the industrial community."

Irma Mikonsaari
Coordinator of CREATOR Fraunhofer Institute
for Chemical Technology



"Being a SPIRE partner became fundamental for the outreach of two of FLEXnCONFU targets due to the great A.SPIRE support: for the enhancement of Combined Cycle Power Plants flexibility by adapting them to the coupling with unconventional fuels like hydrogen and ammonia, and for natural gas consumption reduction by lowering the amount of greenhouse gases emissions."

Antonio Campanale
Project Manager, RINA



"The results of RETROFEED would not have been possible without the collaboration of the SPIRE association, not only with the funding to demonstrate these near-to-market solutions, but also by supporting us with the dissemination or driving the exploitation of the results."

Diego Redondo
Project Manager, CIRCE Research Centre



"The collaboration within the SPIRE network and with A.SPIRE stimulates knowledge exchange between the industry and the water and waste water sector, and contributes to a mutual understanding of the current and upcoming water challenges stimulating the collaborative effort to develop technologies and solutions."

Gerard van den Berg
Coordinator of ULTIMATE, KWR Water
Research Institute



"Through A.SPIRE we found the best partners from the steel domain area. We also got support for our projects via A.SPIRE news, events and web pages."

Dr. Heli Helaakoski
Research Manager, VTT Technical
Research Centre of Finland



"The SPIRE and subsequent P4Planet Partnership's dedication to advancing circularity, climate neutrality, and economic prosperity throughout Europe is undeniably an example of transformative change in industrial water efficiency. My experience within this dynamic ecosystem has been profoundly enlightening and serves as an emblematic example of collaborative progress in the EU Research and Innovation landscape."

Andrea Rubini
Director of Operations, Water Europe



"I am very grateful that MACBETH and its predecessor project ROMEO have benefited so strongly from the support by A.SPIRE. This visionary European program in sustainable process development is essential to bring our revolutionary concept of catalytic membrane reactors to industrial scale."

Prof. Dr. Robert Franke
Project Coordinator MACBETH, Head of
Hydroformylation Innovation at Evonik Oxeno
GmbH & Co. KG



"IRIS, through its membership of the A.SPIRE association, has the opportunity to co-create cutting edge technological solutions with the Process Industries and to work with world class European academics and research institutions in pushing the boundaries of the state-of-the-art towards achieving climate neutrality by 2050. It has been a privilege for us to coordinate the INCUBIS project, which has helped us to position ourselves as a digital solutions provider for energy symbiosis."

Albert Torres
PMO Manager at IRIS Technology Solutions S.L.



"Thanks to our close collaboration with A.SPIRE, we have strengthened our commitment to innovation and sustainability. Through the association, we have gained access to a network of knowledge and resources that has enabled us to expand our impact in technological research and move towards more efficient and sustainable solutions for current challenges. A.SPIRE has been an invaluable partner on our journey towards a more promising and sustainable future. The events promoted by A.SPIRE give us the opportunity to know more about other projects ongoing, and possible new partners for future projects."

Cristina Vega
Project Coordinator (CAPRI), Fundación CARTIF

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