NKS DIT
Nationale Kontaktstelle zum
EU-Programm Horizont Europa

European research with impact

Success Stories from large-scale Horizon Europe projects in industrial technologies

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Success Stories of large-scale EU projects

Horizon Europe

Horizon Europe is the European Union's key funding programme for research and innovation. It supports scientific excellence, technological development and innovative solutions for key challenges of the future, from climate change and digitalisation through health to industrial transformation and strategic sovereignty. The aim is to strengthen Europe's competitiveness, foster sustainable growth and accelerate the transfer of knowledge and technology between research, industry and society.

The programme has now entered the final phase of its term. At the same time, attention is already turning to the next EU framework programme for research and innovation: for Horizon Europe 2028-2034, the European Commission has proposed a significantly larger budget. This is intended to ensure that research and innovation continue to play a central role in competitiveness, technological sovereignty and the response to societal challenges.

Industrial technologies

In the current EU framework programme, Cluster 4 "Digital, Industry and Space" brings together the funding topics of digitalisation, industry and space. As part of Pillar II, "Global Challenges and European Industrial Competitiveness", it strengthens Europe's leadership in strategic future technologies. For industrial technologies, the focus lies on key enabling technologies, new materials, advanced manufacturing, process technologies, sustainability, decarbonisation and resilient raw-material and supply chains.

Leveraging impact with large-scale projects

This brochure focuses on large-scale EU projects funded under Horizon Europe 2021–2027 in the field of industrial technologies. They illustrate how the programme brings together technological development, industrial demonstration and European cooperation. The projects presented address central transformation tasks: climate-neutral process heat, flexible factories, the circular economy, sustainable chemicals, critical raw materials, CO_2 utilisation and industrial symbiosis.

Most EU projects in the field of digitalisation and industry in Cluster 4 receive EU funding of between 3 and 10 million euros. Looking specifically at the research and development projects within the Innovation Actions (IA) and Research and Innovation Actions (RIA), this group accounts for around 88 percent of projects. Large-scale projects represent a considerably smaller share: approximately 11% receive between EUR 10 million and EUR 20 million, while a further 1.5% receive more than EUR 20 million.

This brochure focuses on projects with a total budget of more than EUR 10 million. Such projects operate on a particularly large scale due to factors such as their technical complexity, the scope of their demonstration activities, the number of partners involved or the integration of technologies into real industrial facilities. Large-scale projects provide the framework to not only develop technologies, but to test them under real-world conditions, integrate them into existing processes and prepare them for subsequent deployment.

At the same time, large-scale projects bring particular requirements. The larger a consortium and the more complex the demonstration environment, the more important clear roles, robust governance structures and sound interface management become. Technical development, industrial integration, data management, exploitation and communication have to be coordinated across many partners, countries and time horizons.

The projects presented show the added value this scale can offer: they bring together European expertise along entire value chains, share technological risks, create critical mass and accelerate the path from research to industrial application. In this way, large budgets do not become an end in themselves, but a lever for a sustainable, digital and competitive industry in Europe.

Outlook: 2027 calls and the Clean Industrial Deal

Even in the final stretch of Horizon Europe, large-scale industrial projects remain important. Alongside the calls in Cluster 4, the "Digital, Industry and Space" area participates in the horizontal call "R&I in Support of the Clean Industrial Deal". The aim is to align research and innovation more strongly with industrial decarbonisation, competitiveness and market proximity. In its 2026-2027 work programme, Cluster 4 explicitly refers to this horizontal Clean Industrial Deal initiative, which is intended to bring R&I solutions closer to market uptake and deployment.

For 2027, two large-scale Innovation Actions are planned: a topic on the decarbonisation of energy-intensive industries with a budget of EUR 125 million, and a topic on Clean Technologies for Climate Action with EUR 140 million. The expected EU funding is EUR 15 to 25 million per project in each case. These Clean Industrial Deal topics therefore directly reflect the focus of this brochure: they target precisely the type of projects that combine industrial demonstration, market readiness, investment readiness and European-scale deployment.

Success Stories

The following pages present selected success stories from large-scale EU projects funded under Horizon Europe. Focusing on industrial technologies, the projects illustrate the breadth of Europe's current transformation challenges, from climate-neutral process heat and flexible factories to the circular economy, sustainable chemicals, critical raw materials, CO_2 utilisation and industrial symbiosis.

Project acronym	Project duration
EEETHOS	11/2024 - 10/2028
FLEX4FACT	06/2022 - 11/2025
PLANETS	11/2024 - 10/2028
PERMANET	10/2024 - 01/2028
EMPHATICAL	11/2024 - 04/2029
IS2H4C	01/2024 - 01/2028
REDOL	12/2022 - 11/2026
THESEUS	12/2024 - 11/2029

Funded by the European Union

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Rethinking process heat – electric and efficient (EEETHOS)

The EEETHOS project develops and demonstrates key technologies to electrify industrial process heat, make better use of waste heat and keep energy-intensive sectors competitive on the path to climate neutrality.

Industrial process heat is one of the major levers of European decarbonisation: it accounts for 16 percent of total final energy demand and 13 percent of greenhouse gas emissions in the EU. While efficient solutions such as industrial heat pumps are already available for temperatures below 150 °C, practical, scalable alternatives to fossil fuels are often lacking for higher temperature ranges.

This is where EEETHOS comes in. The project develops technologies for an energy-efficient, flexible and carbon-free supply of process heat. The focus is on high-temperature heat pumps that provide steam at up to 200 °C, a reverse Brayton heat pump with supply temperatures of up to 300 °C, as well as solutions for heat-pump-assisted drying, superheated-steam drying and the recovery of radiant waste heat.

Five demonstrators in energy-intensive sectors

EEETHOS makes the ambition of large-scale EU projects especially tangible, because the technologies developed do not remain abstract but are tested in actual industrial processes. The key technologies are demonstrated up to Technology Readiness Level (TRL) 7 in five industrial plants. They address central sectors of the European process industry: asphalt, ceramics, pulp and paper, brick and steel. The five demonstrators represent very different industrial starting points – from drying and heating in asphalt, brick and ceramics processes through steam generation in the pulp and paper industry to the recovery of radiant waste heat in steel casting.

The plants are highly integrated into real production processes and are intended to show how electrification, waste-heat use and digital optimisation interact at industrial scale. The aim is not merely to make them more efficient at individual points, but to rethink the heat flows across the entire site. The technologies are scalable for site-wide implementation and can draw on local renewable energy sources. Depending on the application, energy savings of 43 to 86 percent are expected.

High-temperature heat pump technology in an industrial setting. Source/Copyright: DLR

Digital twins as the connecting element

EEETHOS combines hardware development with digital solutions for modelling, monitoring and process control. Digital twins, AI-supported modelling, fault detection and optimisation tools are intended to design and operate the plants so that heat flows are used as efficiently as possible.

The digital services are deliberately designed to be system-agnostic. This means they can be applied beyond the demonstration cases to further sectors of the European process industry. In addition, the consortium develops methods for standardisation, life-cycle assessment, techno-economic evaluation, decarbonisation strategies and new business models.

European cooperation for industrial implementation

The particular strength of EEETHOS lies in bringing together different technological approaches, industrial sectors and demonstration environments within a European alliance. Process heat accounts for more than 60 percent of energy consumption in the European process industry. The sector is under strong political and economic pressure to produce in a more energy-efficient and climate-friendly way without losing its competitiveness.

To this end, EEETHOS brings together 19 partners from nine EU countries. The project structure establishes three priorities:

- Technology development: developing key technologies and cross-cutting methods
- Industrial demonstration: designing, building and testing the technologies in real production environments
- Valorisation: assessing, exploiting and preparing the results for scaling and transfer

Working together along the value chains creates the critical mass needed to validate solutions not only in the laboratory, but under real production conditions.

Impact beyond the project

The results are to be used in several ways after the project ends. Plans include commercial exploitation models for end users, the reuse of research results in follow-up projects, new services and products based on the technological knowledge gained, as well as open-source offerings that enable broad use of the project results.

EEETHOS thus addresses central objectives of Horizon Europe: industrial resilience, reduced dependence on fossil fuels, the digitalisation of industrial processes and the strengthening of a decarbonised, efficient and competitive European industry.

A glimpse of an industrial pilot plant.
Source/Copyright: Greenovate!

Scale as a mark of quality

EEETHOS combines a very large budget, a broad European partner structure and the demonstration of several technologies under industrial conditions. It is precisely this scale that makes it possible to work in parallel on technology development, plant integration, assessment, standardisation and exploitation planning.

EEETHOS shows how climate-neutral process heat can become practically feasible in industry — through electrification, waste-heat use and digital optimisation in real plants.

EEETHOS

Project duration	48 months (11/2024 - 10/2028)
EU funding contribution	14 995 451 Euro
Project no.	101178624
Website/CORDIS	https://eeethos-project.eu/ https://cordis.europa.eu/project/id/101178624
Contact	Benjamin Zühlsdorf, Teknologisk Institut Enrico Jende, Deutsches Zentrum für Luft- und Raumfahrt e. V.

Consortium

- Teknologisk Institut (Denmark, coordination)
- Ethniko Kentro Erevnas Kai Technologikis Anaptyxis / CERTH (Greece)
- Deutsches Zentrum für Luft- und Raumfahrt e. V. / DLR (Germany)
- Fundación Tekniker (Spain)
- Peab Asfalt AS (Denmark)
- Keramourgia Voreiou Ellados Anonymi Etairia / KEBE (Greece)
- Felix Schoeller GmbH & Co. KG (Germany)
- Aperam Stainless Belgium (Belgium)
- Oilon Technology Oy (Finland)
- Svenska Rotor Maskiner International AB (Sweden)
- G. Ligeros & Sia OE (Greece)
- Heaten Germany GmbH (Germany)
- CEE-Engineering (Belgium)
- Universität Stuttgart (Germany)
- Università degli Studi di Genova (Italy)
- PricewaterhouseCoopers Business Solutions AE (Greece)
- Greenovate! Europe (Belgium)
- RISE Research Institutes of Sweden AB (Sweden)
- Pirobloc S.A. (Spain)

Flexible factories for the energy transition (FLEX4FACT)

FLEX4FACT develops digital tools and an industrial flexibility platform that bring together production processes, renewable energy, storage and energy markets. The goal is to make factories more flexible, more climate-friendly and more competitive.

As the share of renewable energy grows, so does the need for flexibility: electricity generation and consumption have to be coordinated better. The industrial sector in particular is an important lever here. It is one of Europe's largest energy consumers and at the same time holds previously under-utilised potential to shift energy flows in time, integrate its own generation or make sensible use of surplus energy. FLEX4FACT starts at this interface. The project develops an end-to-end solution that considers production processes, local energy supply, storage technologies and external energy markets together – from the individual machine to participation in flexibility and demand-response markets.

Digital tools for flexible factories

At the centre are digital twins of industrial processes, real-time data, intelligent control systems and cloud-based services. They are intended to bring production planning and energy management together: flexible loads can be shifted, renewable energy and storage better integrated, and surplus energy flows made available for self-consumption or external users. The platform is modular and transferable to different company sizes, types of production and regional energy systems. Via the cloud platform, industrial sites can also offer their flexibility externally and couple with energy grids or energy communities. In this way, energy is not only saved – its temporal availability becomes an economic value.

Five pilots in real industrial environments

The tools developed are demonstrated and validated in five industrial environments. They represent different types of manufacturing, company sizes and locations. The industrial partners involved include, among others, Barna Steel in Spain, Standard Profil Spain, Inaventa Solar in Norway, SEACSUB in Italy and Theben in Germany. The platform is therefore not tested on a single prototype, but in different industrial contexts – from energy-intensive processes and industrial manufacturing to the integration of local energy generation.

FLEX 4 FACT

Flexibility across site boundaries

The project brings together a broad European consortium and, accordingly, has a substantial budget. This scale makes it possible to develop production processes, energy systems, digital twins, storage, market interfaces and business models together. Energy flexibility is thereby treated as a systemic question: not only are individual plants optimised, but entire industrial sites are linked with renewable energy, storage, grids and flexibility markets.

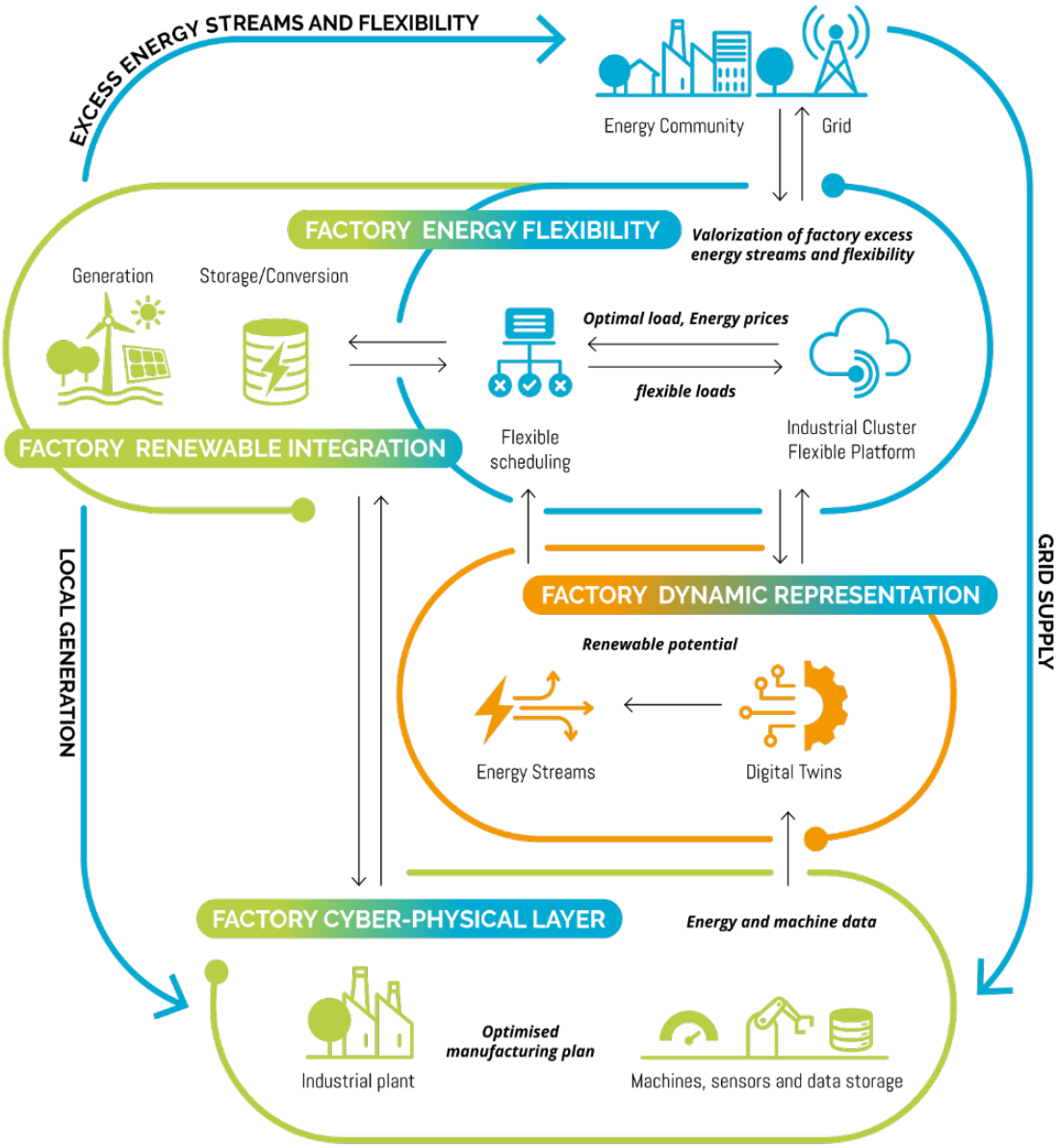
The added value of European cooperation lies in combining industry, research, software development, energy expertise and market logic. The consortium brings together partners from Norway, Spain, Germany, Italy and Ireland and can test solutions under different market and site conditions.

Albstadt-Sigmaringen University is involved as a German project partner. Experience shows that a large, interdisciplinary EU project is not only technologically demanding, but also strengthens scientific exchange and the advancement of the state of the art across national borders.

Impact beyond the project

Beyond the project term, a Memorandum of Understanding is intended to secure cooperation, knowledge exchange and exploitation of the results: the plan is to make methods, instruments and tools available to further industrial partners, so that more companies gain access to flexibility solutions and European electricity markets. In this way, the project strengthens not only individual pilot sites, but a European innovation environment for energy-flexible, digitally connected and more climate-friendly factories.

FLEX4FACT addresses sustainability, digitalisation and competitiveness at the same time: companies can reduce CO2 emissions and energy costs, make better use of renewable energy and open up new revenue streams from demand-response services.



Schematic of the FLEX4FACT platform: industrial energy flexibility, digital twins, renewable energy and grid supply are linked together. Source/Copyright: flex4fact.eu/about

FLEX4FACT

Project duration	42 months (06/2022 - 11/2025)
EU funding contribution	17.997.020 Euro
Project no.	101058657
Website/CORDIS	https://flex4fact.eu/ https://cordis.europa.eu/project/id/101058657/results https://www.hs-albsig.de/forschungsdetailseite/flex4fact/
Contact	Chiara Caccamo, SINTEF Energi AS Ragnhild Eleftheriadis, SINTEF AS
Consortium	• SINTEF AS (Norway, coordination) • SINTEF Energi AS (Norway) • Universitat Politècnica de Catalunya / UPC (Spain) • Instituto Tecnológico de Aragón / ITA (Spain) • Steinbeis Innovation gGmbH (Germany) • Evolvere S.p.A. Società Benefit (Italy) - administratively replaced by Eni Plenitude • Aingura IIoT SL (Spain) • We Plus S.p.A. (Italy) • Centro di Competenza START 4.0 (Italy) • Standard Profil Spain S.A. (Spain) • Inaventa Solar AS (Norway) • SEACSUB S.p.A. (Italy) • Barna Steel S.A. (Spain) • University College Cork / UCC (Ireland) • Capgemini Engineering Deutschland SAS & Co. KG (Germany) • Hochschule Albstadt-Sigmaringen (Germany) • Institutt for Energiteknikk / IFE (Norway) • Rheinisch-Westfälische Technische Hochschule Aachen / RWTH Aachen (Germany) • STAM S.r.l. (Italy) • Sener Ingeniería y Sistemas S.A. (Spain) • Theben AG (Germany) • Eni Plenitude S.p.A. Società Benefit (Italy)

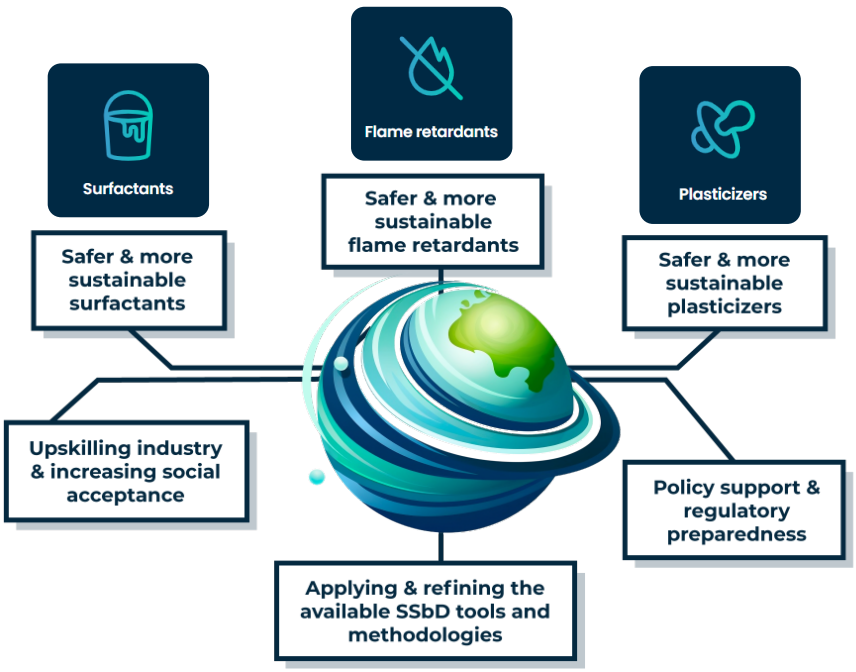
Designing chemicals to be safe and sustainable (PLANETS)

PLANETS develops alternatives to plasticisers, flame retardants and surfactants and demonstrates the “Safe-and-Sustainable-by-Design” approach right through to industrial applications.

Chemicals are the basis of many everyday products – from coatings and insulation materials to materials for sensitive applications. At the same time, requirements for safety, sustainability and regulatory readiness are rising. This is exactly where PLANETS comes in: the project develops safer and more sustainable alternatives to three important classes of chemicals: surfactants, flame retardants and plasticisers. The focus is on the European “Safe and Sustainable by Design” (SSbD) approach. New molecules and formulations should not be assessed only at the end of their development. Safety, sustainability, technical performance and economic feasibility are considered together from the outset. PLANETS thereby translates the goals of the European Green Deal and the Chemicals Strategy for Sustainability into concrete industrial development processes.

Three case studies, one assessment framework

The technical work is organised along three case studies. For surfactants, new molecules are to be developed that are produced free of the by-product 1,4-dioxane and demonstrated in coating applications. For plasticisers, the focus is on materials that are free from the outset of carcinogenic, mutagenic or reprotoxic substances of categories 1 and 1B (CMR 1A/1B) and are suitable for applications in contact with food for children. For flame retardants, the aim is to find alternatives to problematic halogenated substances, in particular TCPP and low-molecular-weight brominated flame retardants. The background is health and environmental concerns over possible persistent, bioaccumulative and toxic properties. All three case studies are accompanied by shared assessment and decision-making aids.



Six project objectives connect alternative molecules, SSbD tools, regulatory preparation and qualification. Source/Copyright: © PLANETS

PLANETS integrates hazard and exposure assessment, life cycle assessment, life cycle costing, and social sustainability assessment. The resulting data are managed according to the FAIR principles (findable, accessible, interoperable and reusable) and provide feedback for the further development of the SSbD framework.

Focus on flame retardants

The Fraunhofer Institute for Chemical Technology (ICT) plays a central role in the project: it leads the work package on SSbD alternatives for flame-retardant applications. There, classes of flame retardants and formulations are optimised, tested, scaled up and trialled in industrially relevant foam applications – including extruded polyethylene foam (XPE), expanded polystyrene (EPS) and rigid polyurethane foam (PU).

Thermal insulation foams are relevant for Europe for two reasons: they help to reduce the energy demand of buildings. At the same time, because of their low density they are difficult to transport economically over long distances, so that regional production sites in Europe play an important role. In addition, there are health and environmental concerns regarding certain halogenated flame retardants. PLANETS thus takes up a use case that combines technical performance, safety, sustainability and market relevance. For the new solutions, lower emissions of volatile organic compounds (VOCs) and improved recyclability are expected. The key point is not only the substitution of individual substances, but also how alternative chemicals can be assessed during the early stages of development, considering their entire value chain and subsequent translation into production processes.

Scale as a mark of quality

PLANETS combines a large budget, 18 partners from seven countries and three industrial case studies. The broad SSbD approach requires expertise ranging from molecular design, process development and materials testing to toxicology, exposure assessment, life-cycle assessment, costs, social impacts and regulatory questions.

The European added value lies in this breadth across the value chains. Research institutions, industrial companies, small and medium-sized enterprises (SMEs) and other actors contribute complementary perspectives.

Impact beyond the project

PLANETS is intended not only to yield new molecules and materials, but also to make applying the SSbD framework easier. The project trials the guidance of the European Commission's Joint Research Centre (JRC), identifies challenges for research institutions as well as large and small companies, and provides training materials. This creates decision aids for future substitutions and contributions to industry's regulatory readiness. Through workshops, training and the involvement of relevant stakeholders, PLANETS strengthens qualification, societal acceptance and European sovereignty in sustainable chemistry.

PLANETS relies on “Safe and Sustainable by Design” (SSbD): technical performance, safety, sustainability and economic feasibility are considered together from the outset.

PLANETS project consortium. Source/Copyright: © CEA

PLANETS

Project duration	48 months (11/2024 - 10/2028)
EU funding contribution	14.458.040 Euro
Project no.	101177608
Website/CORDIS	https://www.project-planets.eu/, https://cordis.europa.eu/project/id/101177608
Contact	Dr. Carl-Christoph Höhne, Fraunhofer ICT

Consortium

- Commissariat à l'énergie atomique et aux énergies alternatives / CEA (France, coordination)
- Netherlands Organisation for Applied Scientific Research / TNO (Netherlands)
- Industrial Technical Center of Plastics and Composites / IPC (France)
- Syensqo (France)
- Fraunhofer-Institut für Chemische Technologie ICT (Germany)
- Paris Lodron University Salzburg (Austria)
- Wacker Chemie AG (Germany)
- Elkem Silicones (France)
- Greenchemicals S.r.l. (Italy)
- BASF SE (Germany)
- Steinbacher Dämmstoff GmbH (Austria)
- Chemische Fabrik Budenheim KG (Germany)
- STERNE, EXSTO Group (France)
- QSAR Lab Ltd. (Poland)
- Radboud University Nijmegen (Netherlands)
- Rina Consulting S.p.A. (Italy)
- AIMEN Technology Centre (Spain)
- BioNanoNet Forschungsgesellschaft mbH (Austria)

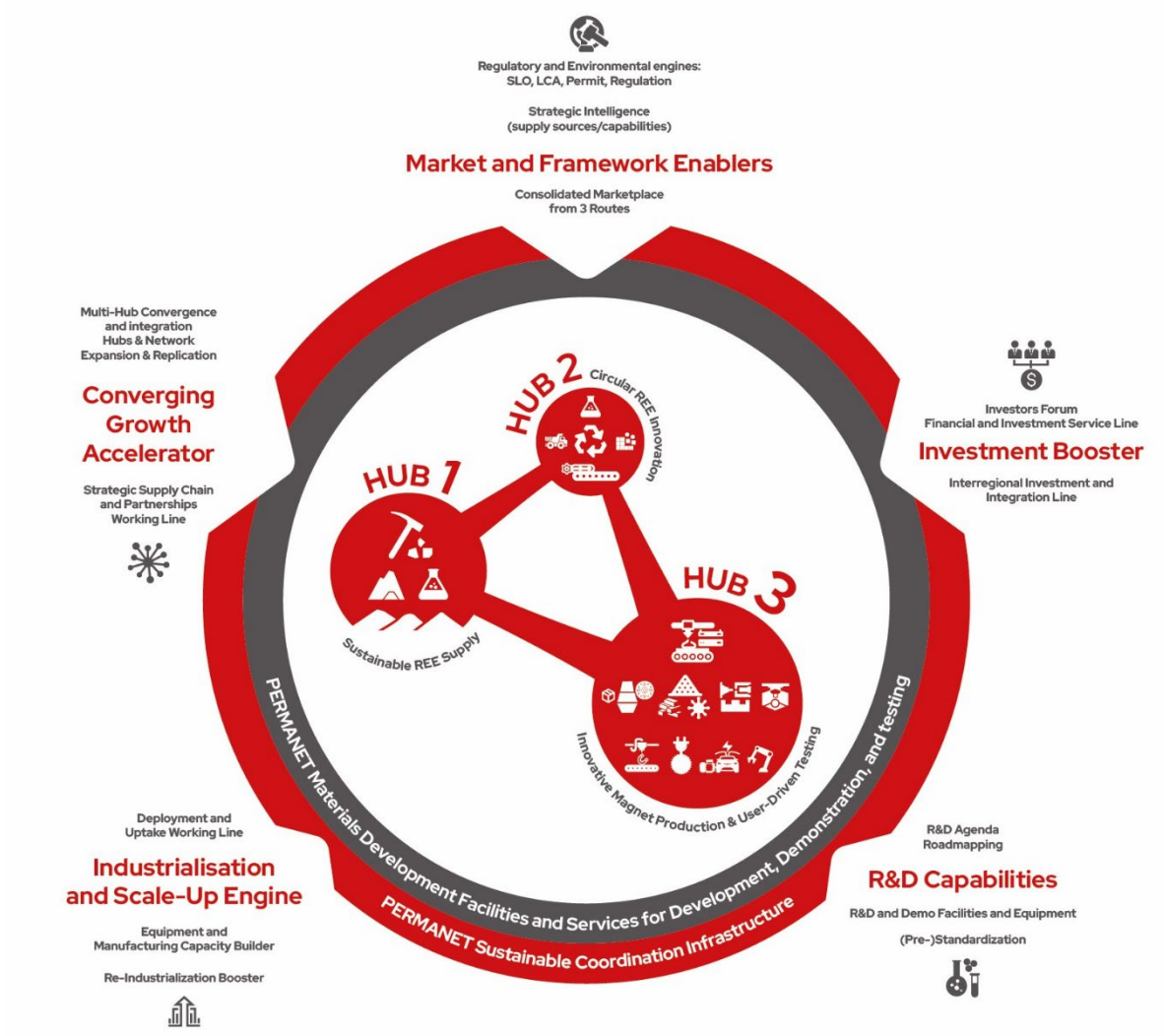
Permanent magnets for Europe's industrial transformation (PERMANET)

PERMANET is building a European innovation and supply network for rare earths and permanent magnets – from sustainable raw-material supply and the circular economy to magnet manufacturing and application testing.

Permanent magnets are found in electric motors, wind turbines, electronics, robotics and many other products that are central to the green and digital transformation. High-performance magnets, however, require rare earths. Europe's industry is heavily dependent here on non-European supply chains, while demand, geopolitical risks and sustainability requirements are all rising at the same time. The project starts precisely at this strategic bottleneck. It aims to make Europe's supply of rare earths and permanent magnets more resilient, more sustainable and more independent. To this end, previously fragmented competences from raw-material extraction, processing, recycling, magnet production and industrial application are brought together in a shared network.

A network for Europe's magnet value chain

The approach ranges from sustainable raw-material sources and end-of-life streams through processing, recycling and innovative



Three tech hubs and enablers of the PERMANET network. Source/Copyright: https://www.permanetproject.eu/

production methods to the validation of new magnets by industrial end users. This addresses not just a single technology, but the entire value chain for permanent magnets based on rare earth elements (REE).

Three tech hubs as structure

The project is built around three sustainable, interconnected tech hubs. The Sustainable REE Supply Hub focuses on sustainable sources and extraction methods. The Circular REE Innovation Hub addresses circular solutions from waste electrical and electronic equipment as well as from further end-of-life streams. The Hub for Innovative Magnet Production & User-Driven Testing brings together new manufacturing processes with application testing in industrial environments. In this way, individual innovation pathways become a European demonstration and service infrastructure for the entire magnet value chain.

From the laboratory to industrial scale

Central milestones are the development of 13 scalable innovations intended to reach higher technology readiness levels, as well as the establishment of a Europe-wide R&D and demonstration infrastructure. It is intended to pool research, piloting, testing and validation services and to ease companies' access to specialised services.

The technological range is broad: it extends from tapping sustainable and even unconventional raw-material sources through recycling and separation processes to innovative magnet-production methods such as powder production, sintering, bonding or additive processes. At the end comes testing in real applications, including in e-mobility, energy and industrial equipment.

Strategic strength through European cooperation

PERMANET combines a very large budget, 32 partners and a value chain that reaches from raw material to application. It is precisely this scale that makes it possible to work in parallel on technical development, demonstration, market mechanisms, investment questions and standardisation.

The European added value lies in bringing previously fragmented competences together in a shared innovation and supply network. Research institutions, industrial companies, recycling actors, raw-material partners, associations, clusters and end users contribute complementary perspectives. This means solutions can be tested not only in individual countries, but embedded in a European structure for development, demonstration and later market launch.

The project supports overarching European objectives such as competitiveness, resource efficiency and technological sovereignty. It contributes to the Critical Raw Materials Act, the Green Deal and the European resilience agenda by reducing dependencies and strengthening the circular economy in a strategically important value chain.

Impact beyond the project

Beyond the funding period, a lasting PERMANET structure is to be created. Plans include follow-up and scaling activities, a sustainable business model after the project ends, and integration into related European initiatives and clusters. The aim is a platform that continuously prepares innovation pathways, investment models and market mechanisms for circular REE and magnet solutions.

PERMANET shows that Europe's industrial transformation needs not only new technologies but resilient value chains. To achieve this, the project links sustainable raw-material sources, recycling, magnet manufacturing and industrial application in a European network.

PERMANET

PERMANET

Project duration	40 months (10/2024 - 01/2028)
EU funding contribution	15.998.160 Euro
Project no.	101178444
Website/CORDIS	https://permanetproject.eu https://cordis.europa.eu/project/id/101178444
Contact	Dr. Martin Brüll, Schaeffler

Consortium

- Técnicas Reunidas (Spain, coordination)
- Politecnico di Milano (Italy)
- MagREEsource Technology (France)
- Ford Otosan Corporation (Turkey)
- Magnosphere GmbH (Germany)
- MAG (France)
- Fundació Privada Centre CIM UPC (Spain)
- Ingeniería Magnética Aplicada (Spain)
- Institute of Physics, Slovak Academy of Sciences (Slovakia)
- ZEOS (Slovenia)
- Lomartov SL (Spain)
- Primum d.o.o. (Slovenia)
- Metalpine GmbH (Austria)
- TECOS Slovenian Tool and Die Development Centre (Slovenia)
- Leonore Development SL (Spain)
- Erion Compliance Organization (Italy)
- Iberian Sustainable Mining Cluster (Spain)
- National Institute for R&D of Materials Physics (Romania)
- N-ABLE (France)
- Kolektor KFH (Slovenia)
- Rhodia Opérations S.A.S. (France)
- ETRA d.o.o. (Slovenia)
- WEEE Forum (Belgium)
- Université de Liège / GeMMe (Belgium)
- Pensana PLC (United Kingdom)
- MNLT Innovations (Greece)
- Centro Ricerche Fiat / Stellantis (Italy)
- Filar-Optomaterials (Italy)
- Reservas Estratégicas y Sostenibles SL (Spain)
- Vitesco Technologies / Schaeffler (Germany)
- Áridos do Mendo (Spain)
- ECOTIC (Romania)
- Electrão (Portugal)

E-methanol from metallurgical off-gases (EMPHATICaL)

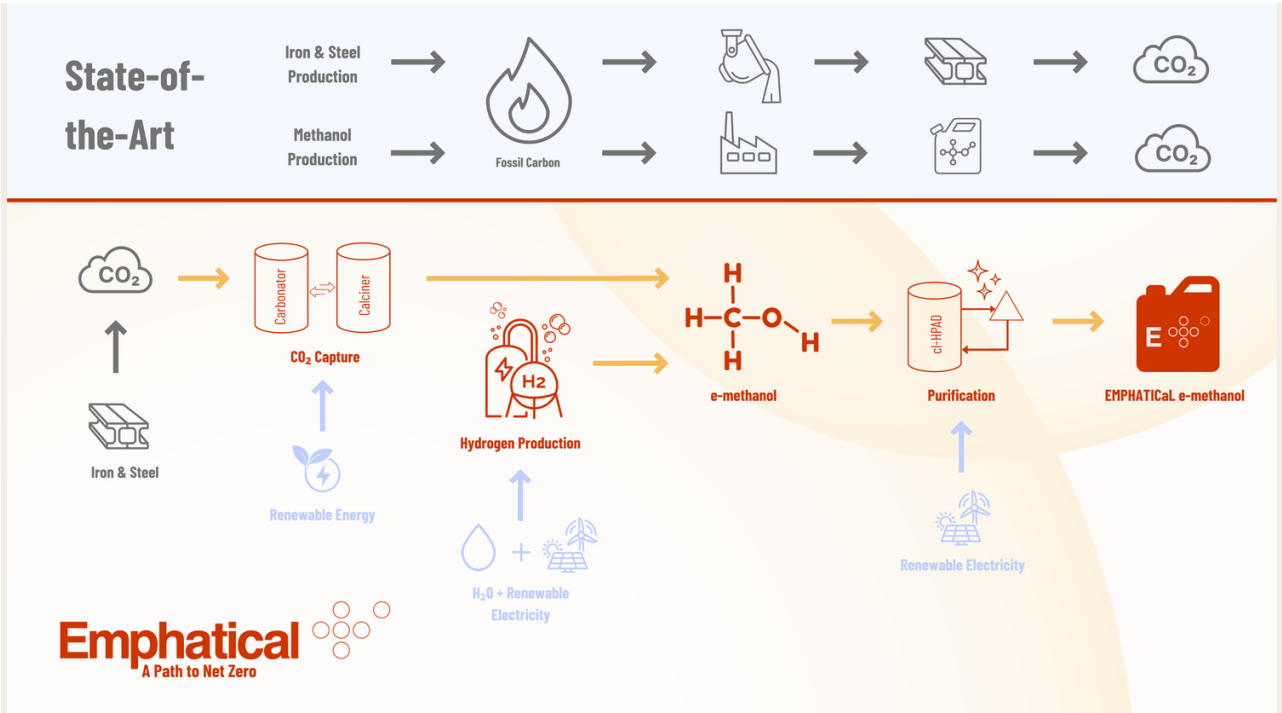
EMPHATICaL develops an industrial demonstrator that converts residual CO and CO_2 from electrified metallurgical processes into e-methanol using green hydrogen. In this way, hard-to-avoid residual emissions become a feedstock for lower-carbon value chains – and decarbonisation becomes a concrete industrial use case.

The metallurgical industry faces the task of using residual CO and CO_2 emissions from highly electrified processes and, at the same time, opening up new pathways for a circular carbon economy. This is exactly where EMPHATICaL comes in: residual gases from steel and ferrochrome production should no longer be seen only as a source of emissions, but as a feedstock for e-methanol.

The project combines CO_2 capture, purification, hydrogen integration and methanol synthesis into a continuous process chain. Green hydrogen and renewable energy form the basis for producing a chemical energy carrier and raw material from industrial residual gases.

A demonstrator at TRL 7

At the heart of the project is a first-of-a-kind demonstrator intended to advance the technologies from Technology Readiness Level (TRL) 5 to TRL 7. The process is demonstrated with two types of industrial residual gas: from secondary steel production in an electric arc furnace and from submerged arc furnaces in ferrochrome production. The aim is not only to use CO_2, but to make the overall process viable in economic and energy terms. The goal is to cut specific energy consumption and production costs by 25 percent each.
In doing so, the project addresses a central barrier to the industrial scale-up of CO_2 capture and utilisation (Carbon Capture and Utilisation, CCU).



Integrated process chain of CO2 capture, hydrogen production and e-methanol synthesis.
Source/Copyright: EMPHATICaL

Digitalisation and process control

Digital technologies are firmly integrated into the project: AI-based process control, advanced process models and system-optimisation tools are intended to improve efficiency and make operation more flexible. This allows the process chain to be thought through more effectively together with renewable energy and future smart energy systems.

Integrating heat efficiently

An important German contribution lies in process integration and in high-temperature heat pump technologies. The German Aerospace Center (DLR) uses EMPHATICaL to further develop these technologies within a complete industrial e-methanol value chain and to demonstrate them under near-real conditions. This brings a central efficiency lever into focus: not only must the individual process steps work, but also their energetic coupling. Heat, compression, capture and synthesis have to interact in such a way that the overall process becomes economically and industrially scalable.

Scale for a complete process chain

EMPHATICaL demonstrates a complete process chain at industrially relevant scale. The large budget and the European partner structure make it possible to carry out plant construction, integration, test operation, digitalisation and assessment in parallel.

The consortium brings together expertise along the entire value chain: from CO_2 capture, purification and hydrogen integration through to methanol synthesis and industrial validation.

On this basis, a technological concept becomes a robust pathway to industrial application. By 2050, the approach could ultimately enable an annual reduction of 41 million tonnes of CO_2 and thus contribute to competitiveness, sustainability and European sovereignty in climate-neutral industries.

Impact beyond the project

The results are disseminated at scientific conferences and on industry platforms and create foundations for follow-up projects on CO_2 capture, hydrogen integration and e-methanol production. At the same time, the project strengthens European collaborations in areas such as high-temperature heat pumps, thermal system modelling and advanced compression technologies.

Residual emissions become a raw material: EMPHATICaL shows how electrification, CO2 use and e-methanol production can grow together into an industrial value chain.

EMPHATICaL

Project duration	54 months (11/2024 - 04/2029)
EU funding contribution	17.295.057 Euro
Project no.	101177725
Website/CORDIS	https://www.emphatical.eu/ https://cordis.europa.eu/project/id/101177725
Contact	Yvonne van Delft, TNO Michael Lockan, Deutsches Zentrum für Luft- und Raumfahrt e. V.

Consortium

- TNO (Netherlands, coordination)
- INERIS (France)
- Politecnico di Milano (Italy)
- CO2 Value Europe AISBL (Belgium)
- CA.RE. for Engineering (Italy)
- Universidad Pontificia Comillas (Spain)
- Technische Universiteit Delft (Netherlands)
- University College London (United Kingdom)
- CSIC (Spain)
- Vargon Alloys Aktiebolag (Sweden)
- Fundacion CIRCE (Spain)
- Sumitomo SHI FW Energi Aktiebolag (Sweden)
- SWERIM AB (Sweden)
- Sumitomo SHI FW Energia Polska Sp. z o.o. (Poland)
- Bright Renewables BV (Netherlands)
- Sumitomo SHI FW Energia Oy (Finland)
- Deutsches Zentrum für Luft- und Raumfahrt / DLR (Germany)
- Celsa Opco, S.A. (Spain)
- Laboratorio Energia Ambiente Piacenza (Italy)
- Sulzer Markets and Technology AG (Switzerland)

Turning industrial areas into Hubs for Circularity (IS2H4C)

IS2H4C takes industrial symbiosis a step further by developing regional circularity hubs, supported by four demonstration hubs and industrial-scale pilot activities. The project demonstrates how energy, material, water and waste streams can be better interconnected and harnessed to support sustainable industrial areas across Europe.

Large integrated chemical and industrial parks have long interconnected energy, material and waste streams across company boundaries. Smaller or less integrated industrial areas, however, often lack the structures and partners needed to unlock comparable synergies. Yet achieving a climate-neutral and resilient industry requires more than making individual plants more efficient: resources, infrastructure and knowledge need to be brought together across company and sector boundaries.

The project “Sustainable Circular Economy Transition: From Industrial Symbiosis to Hubs for Circularity” (IS2H4C) develops solutions for so-called “Hubs for Circularity” (H4C). Within these regional ecosystems, industrial, urban and rural actors are more closely interconnected in order to use resources more efficiently, better integrate renewable energy, prevent waste and reuse or recycle unavoidable solid, liquid and gaseous waste streams.

The focus therefore extends beyond individual companies to the regional industrial ecosystem as a whole. The key question is how actors, infrastructures and resource flows can be connected to create viable circular systems. This is where the added value of this large-scale European collaborative project lies: it provides a common framework for addressing technical demonstrations, data foundations, business models, governance and implementation issues across different sites.

Four demonstration centres in Europe

The technologies and integration approaches developed are implemented in four demonstration centres: in the Netherlands, Germany, Spain and Turkey. These sites represent different industrial and regional starting points. This makes the undertaking a test bed for the question of how industrial symbiosis can be scaled under real conditions. Alongside the development and integration of sustainable technologies, it is also about societal, governmental and entrepreneurial innovation. IS2H4C therefore views H4C not only as a technical solution, but as a model for sustainable regional development. The targets are ambitious: energy consumption is to be reduced by at least 10 percent, waste volumes by at least 20 percent and CO_2 emissions by at least 30 percent. H4C is thereby tested as a model for sustainable regional development in Europe.

Industrial Symbiosis² Hubs 4 Circularity

Making cooperation visible

A key element is the DigitalH4C digital collaboration platform. It maps resources, infrastructures and information flows within the H4Cs and links them to decision-support modules. This makes potential synergies visible: Which material or energy flows can be shared? Which infrastructure can be used jointly? And which actors need to work together to turn a technical option into a viable circular model?

Industrial symbiosis does not emerge from individual technologies alone. It requires transparency, trust, reliable data and coordinated decision-making. The project therefore combines technical demonstration with questions relating to business models, governance, societal acceptance and collaboration.

CO_2 capture at the Höchst Industrial Park

At the German demonstration site, the focus is on CO_2 capture from the actual flue-gas stream of an industrial combustion plant. The investigations provide data for the design of large-scale capture systems. Their particular value lies in generating robust findings under real operating conditions in an industrial environment.

Pilot plant for CO_2 capture at the Höchst Industrial Park site. Source/Copyright: Dominik Burschardt; usage rights: Infraserv Höchst

The results help assess which technologies and operating modes are suitable for the transition from pilot scale to large-scale application, and which technical, economic and organisational requirements need to be met at industrial sites across Europe.

Scale as a quality factor

The project combines four industrial demonstration sites with a broad European partnership. Experiences from different locations can be compared, adapted and made transferable to other regions. Research organisations, industry, clusters, platform providers and consulting partners contribute complementary perspectives. In this way, IS2H4C tests H4C approaches under real industrial conditions and develops solutions that can be transferred to other sites and regions.

Impact beyond the project

The data and experience generated provide a basis for decisions on the implementation of H4Cs across Europe. They show which technical, economic and organisational requirements need to be met in order to develop robust regional circularity models from individual symbioses.

In this way, the project contributes to key objectives of Horizon Europe: competitiveness, digitalisation, sustainability and European sovereignty. Europe is strengthening its capabilities for the transformation of energy- and resource-intensive industrial sites and developing models whose impact can extend beyond individual pilot installations.

IS2H4C makes visible how individual industrial plants can become regional circular hubs: through the shared use of resources, infrastructures and knowledge.

IS2H4C

Project duration	49 months (01/2024 - 01/2028)
EU funding contribution	19.931.655 Euro
Project no.	101138473
Website/CORDIS	https://is2h4c-project.eu/ https://cordis.europa.eu/project/id/101138473/de
Contact	Tim Schmidt vom Hofe, Infraserv GmbH & Co. Höchst KG

Consortium

- Universiteit Twente (Netherlands, coordination)
- Montanuniversitat Leoben (Austria)
- Technische Universität Dortmund (Germany)
- Tecnalia Research & Innovation (Spain)
- INEGI (Portugal)
- Fraunhofer-Gesellschaft (Germany)
- Fundacion CIRCE (Spain)
- ICCS (Greece)
- AEE - Institut für Nachhaltige Technologien (Austria)
- Fundacion Zaragoza Logistics Center (Spain)
- Energy Efficiency in Industrial Processes / EEIP (Belgium)
- Istanbul Maden ve Metaller Ihracatci Birlikleri (Turkey)
- Cooperatie Waardemakers in Waterstof U.A. (Netherlands)
- Cluster de Energia (Spain)
- Consorcio de Aguas Bilbao Bizkaia (Spain)
- Cooperatie Duurzaam Aadorp U.A. (Netherlands)
- KPMG & Associados SROC S.A. (Portugal)
- Türkiye Petrol Rafinerileri A.S. (Turkey)
- Arcelik A.S. (Turkey)
- Smurfit Kappa Nervion S.A. (Spain)
- Nortegas Energia Grupo S.L. (Spain)
- Sidenor Aceros Especiales S.L. (Spain)
- Sidenor Investigacion y Desarrollo S.A. (Spain)
- Petronor Innovacion S.L. (Spain)
- Calera de Alzo S.L. (Spain)
- Calcinor Servicios S.A. (Spain)
- Lointek Ingenieria y Tecnicas de Montajes S.L. (Spain)
- Lointek Investigacion y Desarrollo S.L. (Spain)
- Spouted Bed Solutions S.L. (Spain)
- Infraserv GmbH & Co. Höchst KG (Germany)
- Crowdhelix Limited (Ireland)
- Iris Technology Solutions S.L. (Spain)
- Workdeck Digital Workplace S.L. (Spain)
- Solar Energy Conversion Power Corporation (Belgium)

Zaragoza as a Hub for Circularity (REDOL)

REDOL is turning urban waste streams into secondary raw materials and piloting Industrial-Urban Symbiosis (I-US) Hubs as a model for circular cities and regions. Using the example of Zaragoza (Spain), the project shows how municipal waste from packaging, plastics, construction and demolition materials, textiles as well as waste from electrical and electronic equipment can be transformed into new value chains and circular products.

REDOL supports Zaragoza and the region of Aragón in building a Hub for Circularity. The project addresses a European problem: cities generate large quantities of municipal solid waste, yet a considerable share is still landfilled or incinerated instead of returning as a resource into new value chains.

The approach combines industrial and urban symbiosis. Municipalities, industry, waste operators, recycling companies, research and citizens are to jointly create new ways for waste streams to become secondary raw materials and, ultimately, circular products.

Five value chains

The focus is on five strategic waste streams: packaging, plastics, construction and demolition waste, textiles, and waste electrical and electronic equipment. From these, twelve circular products are to be created, including recycled paper, plastic bottles and bags, automotive components, reinforced particleboard, cement- and concrete-based products, recovered metals and PET yarns.

The pilot in Zaragoza

The demonstration is anchored in Zaragoza and supports the city's ambition to become a zero-residue city by 2040. The solutions are not developed in isolation but tested along real value chains: collection, sorting, recycling, digital traceability, logistics and industrial processing interlock. This includes six newly developed sorting devices to be deployed and tested in operational environments, optimised recycling routes and the creation of a digital platform for data exchange, coordination and traceability. This makes visible which material streams are available, what quality they have and how they can be integrated into downstream industrial applications.

Sorting and collection solutions for urban waste streams.
Source/Copyright: REDOL project

Replication in Europe

Besides Zaragoza, Prato in Italy, Bornholm in Denmark and Amsterdam in the Netherlands are involved as replication zones. They are to examine how REDOL solutions can be adapted to different urban and industrial starting points, creating local hubs with tailored governance models and action plans.

Circular economy at European system scale

REDOL combines demonstration, digitalisation, governance, citizen participation and replication. It is precisely this breadth that defines the character of the project: the circular economy is understood not as a single recycling solution, but as the interplay of technology, infrastructure, business models and local governance.

The European added value lies in bringing together very different actors. Research institutions, cities, technology developers, recyclers, industrial companies and networks combine technical, organisational and policy knowledge. This means circular value chains can be developed not only in Zaragoza, but made transferable to other urban and industrial areas in Europe.

Industrial sorting and recycling environment.
Source/Copyright: REDOL project

Impact beyond the project

An important result is the creation of long-term structures such as the Aragón Circular Economy Cluster CIRCLEAR, expanding the hub in Zaragoza to the whole region of Aragón in Spain. The launch of this cluster created a regional platform to network actors from business, research, administration and local institutions to join forces and work towards common circular economy goals. In addition, the project has condensed learnings from Zaragoza and other inspiring I-US initiatives around Europe to create Guidelines for Hubs for Circularity, meant to provide a support to anyone interested in establishing or supporting the creation of a local hub for I-US. At the same time, identified legislative and policy barriers are informing the drafting of recommendations for European policymakers for adjusting key policies and boosting the adoption of symbiotic solutions in Europe.

The impact thus reaches beyond the demonstration in Zaragoza. The experience from the value chains, the digital platform and the cooperation between city, industry and the waste sector creates a basis for building industrial-urban symbioses in other European regions too and adapting them to local conditions.

Redol

REDOL shows how cities can become circular hubs: waste is understood not as a residue but as a resource for new industrial value creation. To achieve this, the project links collection, sorting, recycling, digital traceability and industrial processing into new circular value chains.

REDOL

Project duration	48 months (12/2022 - 11/2026)
EU funding contribution	14.292.023 Euro
Project no.	101091668
Website/CORDIS	https://www.redolproject.eu/ https://cordis.europa.eu/project/id/101091668
Contact	Diego Redondo Taberner, CIRCE Research Centre (REDOL Coordinator) Chiara Coluccia / Victoria Miles, ICLEI Europe

Consortium

- CIRCE Research Centre (Spain, coordination)
- Fundación AITIIP (Spain)
- AITEX - Asociación de Investigación de la Industria Textil y Cosmética (Spain)
- ICCS / NTUA (Greece)
- ITENE - Instituto Tecnológico del Embalaje, Transporte y Logística (Spain)
- Instituto Tecnológico de Aragón / ITA (Spain)
- Universidad de Zaragoza (Spain)
- Next Technology Tecnotessile (Italy)
- Luleå Tekniska Universitet (Sweden)
- VDZ Technology gGmbH (Germany)
- AMS Institute - Amsterdam Institute for Advanced Metropolitan Solutions (Netherlands)
- Tatuine Medioambiente SL (Spain)
- Casale Gestión de Residuos SL (Spain)
- IRIS Technology Solutions SL (Spain)
- Moses Productos SL (Spain)
- Brilen Tech SA (Spain)
- Suite5 Data Intelligence Solutions Limited (Cyprus)
- Nuevas Tecnologías para Packaging y Agroalimentarios (Spain)
- Strane Innovation (France)
- Geonardo Kft. (Hungary)
- RINA Consulting - Centro Sviluppo Materiali (Italy)
- ACTECO Productos y Servicios SL (Spain)
- AMB Electrónica Brescia SL (Spain)
- SAICA Natur SL (Spain)
- Acciona Construcción SA (Spain)
- Cemex España Operaciones SL (Spain)
- Financiera Maderera SA / Finsa (Spain)
- ICLEI European Secretariat GmbH (Germany)
- Energy Efficiency in Industrial Processes ASBL (Belgium)
- Ayuntamiento de Zaragoza (Spain)
- Comune di Prato (Italy)
- Bornholms Regionskommune (Denmark)
- Consorcio de la Agrupación N1 para la Gestión de Residuos Sólidos Urbanos de Huesca (Spain)

Attica as a living lab for circular regions (THESEUS)

THESEUS makes Attica a living lab for circular regions. The project networks cities, industry and research to use water, energy and material streams more efficiently and to return by-products as resources. The result is a Hub for Circularity that trials the circular economy under real conditions and is intended to be transferable to further regions.

Many cities and regions face the same challenge: resources are used, waste is generated, and energy and material streams run side by side without fully exploiting their potential. Yet by-products, residues and previously unused material streams could become new starting points for regional value creation. The THESEUS project is building the first Hub4Circularity (H4C) in Greece and developing solutions that more closely network cities, industry, research and other actors.

Attica as a living lab

The starting point is the region of Attica with the Athens metropolitan area, the country's economic centre. The region comprises 68 municipalities, around 3.7 million inhabitants and numerous industrial and urban areas. It thus offers a demanding environment in which to trial circular solutions not abstractly, but under real conditions. Attica is seen here as a starting point for a broader transformation. Solutions developed are to be transferred step by step to further parts of Greece and, prospectively, to other European regions. The particular emphasis is on concrete local implementation: water, energy and material streams are examined under real conditions, digital tools support planning and control, and municipalities, industry and research are involved in joint pilot activities.

THESEUS
Hub4Circularity

Managing water, energy and materials together

The focus is on the three areas of water, energy and materials, which are relevant for almost all European regions. THESEUS develops and improves technologies with which these streams can be captured, managed and used more efficiently. The aim is to unlock the previously unused potential of by-products and waste and to build new regional loops from it. Digital platforms, data spaces as well as AI and robotics solutions support the capture, analysis and optimisation of resource streams. They help to make material quantities, qualities, energy needs and usage options visible. This creates an operational basis for planning pilot measures, involving local actors and implementing circular solutions step by step.

Marble dust as a resource

The Technische Universität Dresden contributes its expertise in sustainable building materials and the circular economy. One focus is the use of marble dust in concrete technology. In Greece and other regions, this arises in large quantities as a by-product of natural-stone processing and has so far mostly been landfilled. The project investigates how this previously unused raw material can be processed and used as a component of sustainable cement-bound building materials. A by-product of natural-stone processing can become a feedstock for new building-material solutions. The German contribution makes visible how the circular economy can be implemented in practice at the materials level.

European cooperation for regional implementation

THESEUS is a large-scale EU project with a broad, interdisciplinary consortium. The cooperation includes municipalities, research institutions, industrial companies, technology partners, networks and standardisation actors. This breadth is necessary because circular solutions have many interfaces: technical, organisational, economic and political.

Such an undertaking requires clear communication channels, structured cooperation and efficient project management. At the same time, the long-term secured funding creates planning certainty for ambitious solutions. The European added value lies in combining regional implementation in Attica with knowledge, technologies and experience from different countries and disciplines.

Impact beyond Attica

THESEUS is intended to have an effect beyond the project term. The cooperation within the consortium creates a basis for follow-up projects, new cooperation opportunities and additional markets for the industrial partners involved. At the same time, the project strengthens the innovative capacity of the actors involved and supports new value chains in the field of the circular economy.

THESEUS thus contributes to central European objectives: sustainability, digitalisation, competitiveness and technological sovereignty. Through regional material loops, primary resources can be conserved, waste reduced and dependence on imported raw materials lowered. Attica thereby becomes a starting point for solutions that can also become relevant for other European regions.

THESEUS shows how regional by-products can create new value. One example is marble dust from natural-stone processing: instead of being landfilled, it is to become usable as a component of sustainable cement-bound building materials. A previously unused by-product thus becomes a feedstock for sustainable building materials.

THESEUS

Project duration	60 months (12/2024 - 11/2029)
EU funding contribution	19.994.307 Euro
EU project no.	101178059
Website/CORDIS	https://www.theseus-h4c.eu/, https://cordis.europa.eu/project/id/101178059/
Contact	Dr. Angelos Amditis & Charalampos Manousiadis, Institute of Communication & Computer Systems (ICCS) Prof. Dr. Marco Liebscher (TU Dresden)

Consortium

- ICCS / Institute of Communication and Computer Systems (Greece, Coordination)
- CIBOS Innovation (Greece)
- National Technical University of Athens / NTUA (Greece)
- Region of Attica (Greece)
- Develop Athens (Greece)
- Cities Network for Sustainable Development and Circular Economy (Greece)
- DETIP – District Heating Municipal Company of Ptolemaida (Greece)
- Clean Energy Ltd (Greece)
- CERTH – Centre for Research and Technology Hellas (Greece)
- NCSR “Demokritos” (Greece)
- Hellenic Mediterranean University (Greece)
- Democritus University of Thrace (Greece)
- University of the Aegean (Greece)
- Technical University of Crete (Greece)
- TU Dresden (Germany)
- Linköping University (Sweden)
- A.SPIRE (Belgium)
- CORE Innovation Centre (Greece)
- EMVIS S.A. (Greece)
- RISA Sicherheitsanalysen GmbH (Germany)
- TELENAVIS (Greece)
- IRIS Technology Solutions (Spain)
- Fundación CIRCE (Spain)
- Hypertech Sustainability Research and Technology Center (Greece)
- GEOCYCLE (Greece)
- RECYCOM (Greece)
- EYDAP – Athens Water Supply and Sewerage Company (Greece)
- Elvalhalcor / HALCOR (Greece)
- Thrace Marble (Greece)
- Thrace Polyfilms (Greece)
- Northern Greece Ceramics / KEBE (Greece)
- TSIMIS (Greece)
- PANCHART (Greece)
- FIBRAN (Greece)
- COMO (Greece)
- Athenian Brewery (Greece)
- RISE Research Institutes of Sweden (Sweden)
- City of Malmö (Sweden)
- SINTEF Helgeland (Norway)
- SINTEF (Norway)
- Kunnskapsparken Helgeland (Norway)
- Helgeland Ferdigbetong (Norway)
- Danish Standards (Denmark)
- Standards Norway (Norway)
- Imperial College London (United Kingdom)
- University of Huddersfield (United Kingdom)
- Tech Hive Labs (Greece)

Associated partners:

- TVP Solar (Switzerland)
- Mo Industripark (Norway)
- Nordland County Council (Norway)
- Rana Utvikling (Norway)
- Rana kommune (Norway)

Notes on how to apply

Dear prospective applicants,

With the 2026/2027 Work Programme, Horizon Europe has entered the final phase of its current programme period. The Work Programme for Cluster 4, “Digital, Industry and Space”, was published in December 2025 and is complemented by new horizontal calls, including calls in support of the Clean Industrial Deal and on AI in Science.

For applicants, this means that anyone still planning to participate in Horizon Europe 2021–2027 should assess at an early stage which call topics are relevant to their project ideas and which submission deadlines need to be taken into account.

Early preparation is particularly important for large-scale projects. This applies, for example, to the Clean Industrial Deal topics under the Horizontal Work Programme. These calls focus on large-scale innovation projects combining industrial demonstration, market readiness and European-scale deployment. Key elements such as the demonstration approach, consortium structure, exploitation strategy, budget planning, technology readiness development and expected impact should therefore be developed well in advance.

For many topics in the area of digital and industrial technologies, the final submission deadlines already fall in early 2027. For the horizontal Clean Industrial Deal topics, the submission deadline is in September 2027.

Current calls, deadlines and further information are available on the European Commission’s Funding & Tenders Portal:

- Cluster 4 „Digital, Industry and Space“
- Horizontal Activities

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