



———— Power to your know-how ————



"I am delighted to see that SPIRE is continuing to develop and demonstrate breakthrough and key enabling technologies and share best practice across diverse industrial sectors in an unprecedented manner. It is thereby building the foundation to enable the energy and resource efficient, but also competitive, process industry that Europe needs to successfully address climate change and build a fully circular society."

Pierre Joris, Chair of A.SPIRE,
DOMO Chemicals

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of European Process Industry

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“The innovations that SPIRE promotes are deeply linked with Climate Change, both in terms of mitigation and adaptation, for the transition to a more circular economy, and for better synergies between process industry sectors for better resource and energy efficiency.”



CHAPTER 1

Towards the Next Generation of
European Process Industries

1.1: ABOUT A.SPIRE

Launched in 2013, the Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) initiative is a unique Public Private Partnership (PPP) working to deliver a competitive and sustainable process industry for Europe as the basis for a truly sustainable low carbon circular economy. The objective of the SPIRE PPP is to develop the enabling and breakthrough technologies and value-chain solutions required to transform the EU Process Industry and create long-term sustainability for Europe in terms of global competitiveness, ecology and employment.

SPIRE has today become an exemplary benchmark in cross-sectorial cooperation, enabling remarkable energy and resource efficiency gains across complex value chains. Within five years, it has exceeded its research and innovation targets and enabled unprecedented knowledge transfer between industry sectors.

SPIRE works with, and across, eight crucial European industrial sectors: Cement, Ceramics, Chemicals, Engineering, Non-ferrous metals, Minerals, Steel and Water. The SPIRE sectors are of major importance for economic development and a sustainable society,

representing 20% of the total manufacturing industry of which they are the largest investors.

Between 2008 and 2016, SPIRE sectors also outperformed the EU industrial average in terms of reducing energy use, greenhouse gas emissions (GHG) and improved energy intensity. SPIRE sectors' GHG intensity fell by 26%, while total EU industry GHG emissions fell by only 16%.

Embracing industries, research and technology organisations as well as universities, SPIRE is a champion of collaboration and the sharing of best practices. This is attractive to SMEs, which comprise more than a quarter of the total number of the SPIRE project partners. In terms of employment, as well as sales, SMEs involved with SPIRE outperform with double the average EU turnover. We also bring together national, regional and local government bodies to jointly coprogramme and implement research and innovation initiatives that can radically decrease our use of energy and resources.

The SPIRE PPP is based on Article 19 of the EU Research and Innovation Framework Programme Regulation of Horizon 2020 and has been established through a contractual arrangement between the European Commission and A.SPIRE aisbl representing more than 140 major industrial and research process industry stakeholders from across Europe.

SPIRE is implemented through competitive calls included in the European Commission's Horizon 2020 work programmes and other European initiatives.

SPIRE projects under H2020 are:

- Developing new breakthrough process technologies to radically decrease energy intensity.
- Developing breakthrough process technologies to increase resource efficiency, promote industrial symbiosis and enable a sustainable circular economy.
- Accelerating the development and implementation of digital technologies as key enabling technologies for resource and energy efficiency, reducing costs and increasing competitiveness.
- Providing the materials to enable higher energy efficiency and lower GHG emissions in other industrial and commercial sectors.

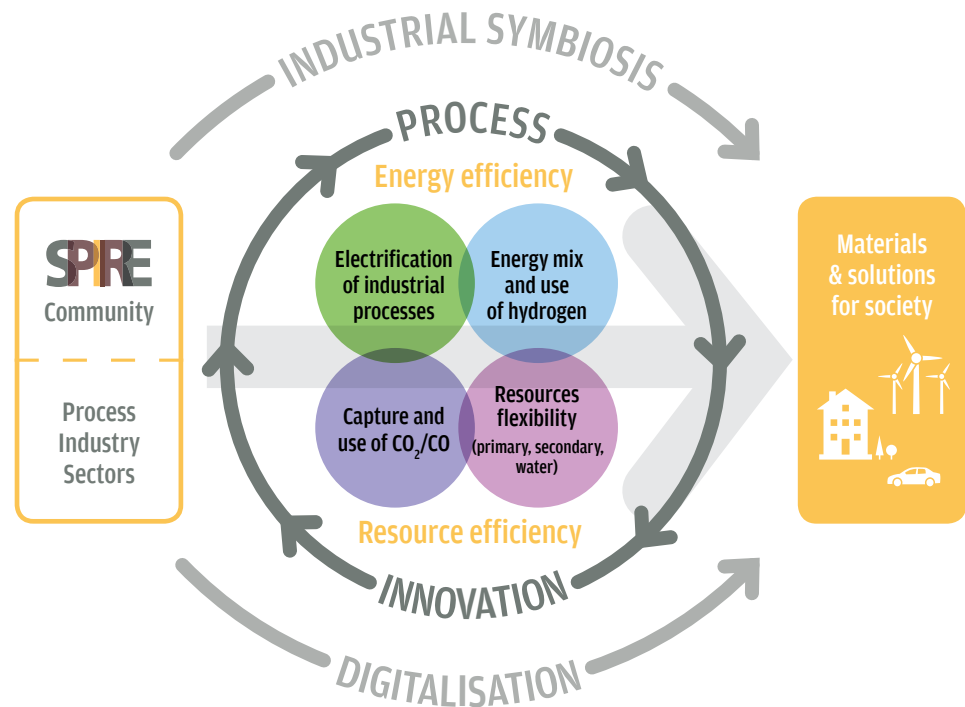
Guided by its ambitious Vision 2050, SPIRE is currently working on new initiatives to contribute to the missions and objectives of the European Commission's forthcoming Framework Programme, Horizon Europe, and the EU long term strategy on Climate Neutrality.



1.2: SPIRE 2050 VISION

All current SPIRE projects are funded through open and competitive calls organised under the Horizon 2020 programme, integral to the SPIRE 2030 Strategic Innovation and Research Roadmap. The next generation of carbon neutral and circular solutions, enabled through collaboration across borders and digitalisation, will be developed and deployed on a much larger scale.

This is highlighted in our new SPIRE 2050 Vision. SPIRE can enable the development of a truly sustainable European economic system in which economic growth is permanently decoupled from environmental impact. Our Value Proposition: “An integrated and digital European Process Industry, fostering a ‘well below 2 degrees’ scenario, and fully circular future for our planet and society.”



SPIRE 2050 VISION

An integrated and digital European Process Industry, fostering a "well-below 2 degrees" scenario and a fully circular future for our planet and society.

This Vision 2050 emerged from intense consultation and dialogue between A.SPIRE sectors and members with relevant stakeholders on their shared research and innovation requirements, their joint challenges and wider societal needs. This new Vision can be achieved through intense integration of SPIRE sectors to boost the transition towards a carbon neutral and circular economy and society.

Energy and Resource Efficiency will remain SPIRE's core focus areas with digitalisation helping to accelerate the transition. Core SPIRE technologies will lead the development of the Next Generation of European Process Industry with multiplier effects generated across the economy. Innovative "industrial ecology" business models will be developed with SPIRE building physical and digital bridges across sectors and countries. The EU Process Industries will become "Hubs for Circularity" for energy and material resources, deploying industrial and urban symbiosis at scale in close collaboration with public authorities and society.

The SPIRE 2050 Vision is paving the way towards a new SPIRE 2050 Strategic Research and Innovation Roadmap for implementation under Horizon Europe. You can download the SPIRE 2050 Vision document [here](#).



1.3: JOIN A.SPIRE

A.SPIRE aisbl is the international non-profit association representing the private sector in SPIRE. With over 140 industrial and research industry members, A.SPIRE members are developing the new SPIRE Roadmap 2050: a multiannual and dynamic industry-led strategy that will address critical research and innovation activities and related policy issues through cross-sectorial collaboration.

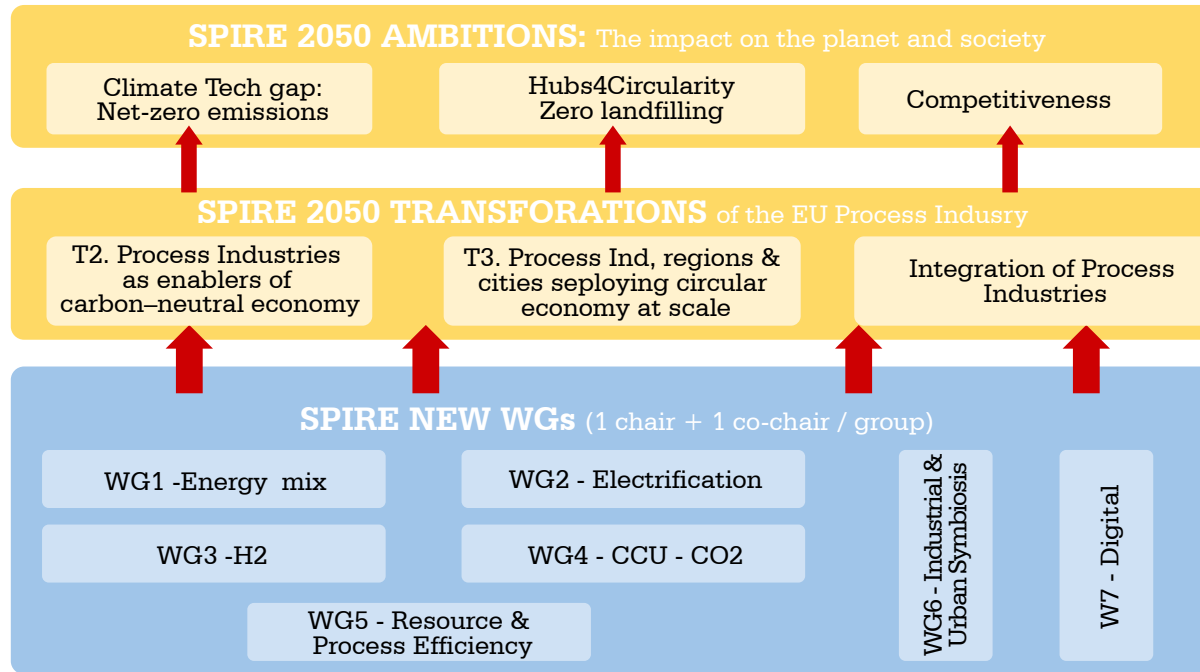
You can team up with A.SPIRE to help address the challenges of Climate Change, Circular Economy and Competitiveness. Together, we can drive Europe to lead the next generation of process industry.

Membership of A.SPIRE enables you to:


- Help shape the future of the process industry and address its research and innovation needs including participation in the working groups (WGs) building the SPIRE Roadmap 2050 that will connect directly with the Horizon Europe programme.
- Provide input to European programmes including Horizon Europe, the New Innovation Fund, the SET Plan and other influential high-level initiatives such as Energy Intensive Industries and Low Carbon value chains.
- Network across eight major industry sectors to find new partners and opportunities through our member-only brokerage activities and other targeted workshops, benefitting from synergies across sectors and cooperating within the EU innovation ecosystem and along entire value chains.
- Get access to knowledge on technological and non-technological developments in the SPIRE community, share best practices, get coaching for SMEs on leveraging relevant funding, get access to a pool of knowledge and talent across academia and industry and have a direct access to SME providers, applied innovation, growth opportunities and new markets, as well as large industry customers.
- Improve your visibility across diverse sectors and players by contributing to the resource efficiency policy debate, getting publicity through the SPIRE website, events, and publications at European and national levels, and reaching out to a wide range of European stakeholders in diverse political and industrial fields.

SPIRE 2050 ROADMAP - NEW WGs

Be a part of it: join us to define the next decades of R&I



Applicants can apply to their corresponding category of which there are three: Industry Membership (open to relevant industrial and commercial companies, associations and clusters); Research Membership (open to research institutes and universities); and Associate Membership (a non-voting category open to non-governmental organisations and other stakeholders that comply with the criteria for the previous two categories). All membership applications must be approved by the A.SPIRE Board. Membership is only open to legal entities established in European countries. Join today!

A hand is holding a glowing yellow lightbulb over a field of green grass. The lightbulb is illuminated from within, casting a warm glow. The background is a dense field of green grass, with some blades in the foreground being slightly out of focus. The overall scene suggests a connection between nature and innovation.

"One value that has been clearly demonstrated is that SPIRE provides a framework for a consistent strategy that achieves a very high impact with respect to innovation. The cross-sectorial nature of SPIRE, in particular ensures that innovations that are proposed and realised have a much wider impact."



2.1: EFFICIENT PROCESS

OVERVIEW

By the end of 2018 SPIRE had already selected and commissioned some 89 innovative projects under the European Commission's Horizon 2020 programme. These projects benefitted from a total estimated private investment of three billion EUR, representing a seven-fold leverage on the public funds contributed, and had developed 221 new systems and technologies – a remarkable achievement! With more to come!

SPIRE projects can be classified into three broad topic areas: 'Efficient Process', 'Sustainability and Circular Economy', and 'Enabling Sustainable Industry Development'.

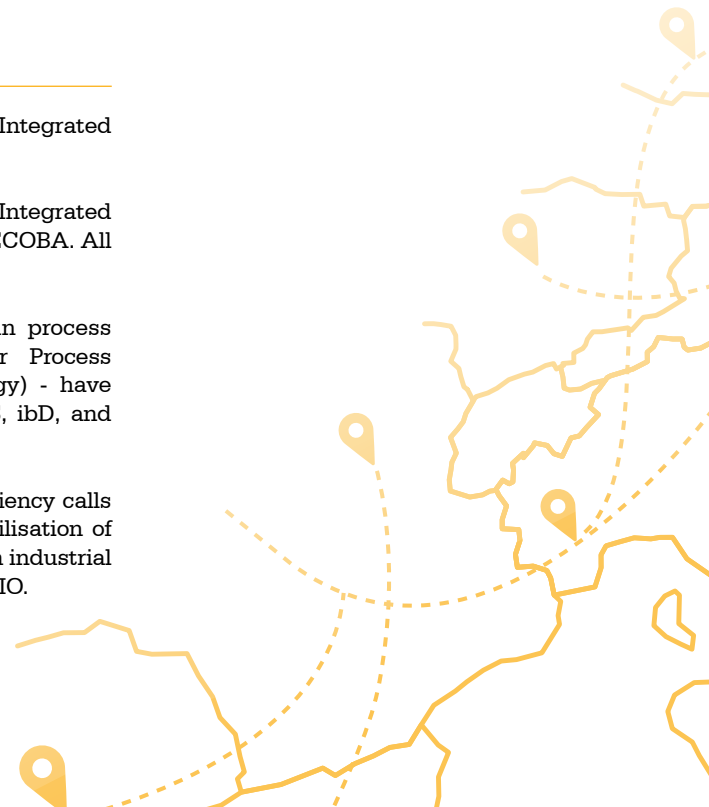
EFFICIENT PROCESS

Within the Efficient Process topic there are three main project call areas: 'Modelling and Integrated Process Control', 'Process Optimisation', and 'Valorisation of (Waste) Energy Sources'.

Modelling and Integrated Process Control was implemented through [call SPIRE-01-2014](#) (Integrated Process Control) that resulted in five projects: CONSENS, DISIRE, iCspec, ProPAT, and RECOBA. All these projects are now completed.

Three SPIRE calls - [SPIRE-03-2014](#) (Improved downstream processing of mixtures in process industries), [SPIRE-05-2015](#) (New adaptable catalytic reactor methodologies for Process Intensification), and [SPIRE-08-2015](#) (Solids handling for intensified process technology) - have implemented Process Optimisation topics and resulted in projects including PRODIAS, ibD, and PRINTCR3DIT that are now completed.

Valorisation of (Waste) Energy Sources has been implemented through two Energy Efficiency calls managed by SPIRE for the European Commission: [EE18-2015](#) (New technologies for utilisation of heat recovery in large industrial systems) and [EE17-2016-17](#) (Valorisation of waste heat in industrial systems). Completed SPIRE projects from the first call include I-Therm, SUSPIRE and TASIO.



Success Story 1:

CONSENS - Modular, Portable Plants for Flexible, Energy Efficient Production

Period: 01/01/2015 – 31/12/2017

Website: www.consens-spire.eu

Disruptive Impact: The CONSENS model facilitates a disruptive process of flexible and portable production right to the door of the customer allowing producers to respond to market dynamics (e.g. mass customization) quickly with reduced investment risk while boosting earnings and drastically reducing emissions and the consumption of raw materials and energy. They aim at reaching a deployment of the modular and portable plants to 20% of the market in the Chemical industry.

Disruptive Innovation: To succeed in competitive global markets, EU manufacturers must strive to adapt to changing customer needs. Digitalisation can play a big role to achieve new and highly flexible production systems that enable certain industries to move from batch production to continuous production. This transformation, however, will require a leap forward in digital process control technologies. CONSENS demonstrated new digital control systems that can be integrated into smaller plant modules for flexible continuous processing in the chemicals and pharmaceutical industry. In addition, the project's intensified and flexible processes is delivering significant economic and environmental benefits for the pharmaceuticals and fine chemicals industry in the EU. Based on estimations, annual earnings can increase by €265 million, while annual emissions and consumption of solvents can reduce by 400,000 tonnes and 176,000 tonnes, respectively.

Success Story 2:

SOLPART – Achieving Low-Carbon Process Industries Through Solar Reactors

Period: 01/01/2016 – 31/12/2019

Website: www.spotview.eu

Disruptive Impact: Through the implementation of this technology, 40% of direct emissions can be reduced at lime and cement plants, while also slashing operating costs by 20%. When coupled with CCS (to capture and store the CO₂ created as a by-product when decomposing limestone), direct emissions could be eliminated at these plants. In addition, the innovation developed to heat industrial processes in the minerals sector, uses an infinite and free source of zero-carbon energy: the sun, as opposed to fossil fuels.

Disruptive Innovation: Three quarters of energy consumed by industry is used for heating and cooling, the vast majority of this is produced by burning fossil fuels. This combustion accounts for a sixth of EU emissions as well as a large share of industrial operating costs. To meet ambitious mid-century climate targets and help European process industries thrive in global markets, the EU must develop technologies that can deliver low-carbon heating and cooling at competitive prices. SOLPART's pilot solar reactor will operate at over 50% efficiency, with 30 kWth power, producing 30 kg of quicklime an hour, compared to the current state of the art of 30% efficiency, 10 kWth power, and 4 kg quicklime an hour. In addition, SOLPART's integration of a storage system for heated solids within the process, will allow the system to provide 900 °C heat continuously, rather than only for a maximum of one hour.

2.2: SUSTAINABILITY AND CIRCULAR ECONOMY

This is a wide-ranging topic with three call areas: 'Adaptable Processes using Alternative Feedstock', 'Recovery from Waste', and 'Industrial Symbiosis and Water'.

Adaptable Processes using Alternative Feedstock has been implemented via two calls: [SPIRE-02-2014](#) (Adaptable industrial processes allowing the use of renewables as flexible feedstock for chemical and energy applications) and [SPIRE-05-2016](#) (Potential use of carbon dioxide/ carbon monoxide and non-conventional fossil natural resources). Four projects from these calls are now complete: CarbonNext, MefCO2, MOBILE FLIP and SteamBIO.

Implementation of Recovery from Waste has been through two calls - [WASTE-1-2014](#) (Moving towards a circular economy through industrial symbiosis) and [SPIRE-07-2015](#) (Recovery technologies for metals and other minerals) – resulting in eight projects of which five are now completed: BAMB, CABRISS, REMAGHIC, RESLAG and RESYNTEX.

Industrial Symbiosis and Water featured in a single call - [SPIRE-06-2015](#) (Energy and resource management systems for improved efficiency in the process industries) – resulting in four projects of which only SYMBIOPTIMA has been completed.

Success Story 3: REE4EU – Secure Cost-Effective REE Recycling and Sustainable Value Chains

Period: 01/10/2015 – 30/09/2019

Website: www.ree4eu.eu

Disruptive Impact: Forecasts show that the **EU can recover 90% of Rare Earth Elements (REEs) in targeted manufacturing waste streams and 20% in consumer waste streams**, as opposed to the **global 1% of current REE waste recovery**, halving also its **emissions and energy consumption** compared to the practices of today. Europe will thus be able to **secure a steady supply of REE** by establishing an

entirely new domestic European industry that can produce rare earth alloys indefinitely from waste.

Disruptive Innovation: The technology developed by the REE4EU project allows production time to be reduced, as well as guaranteeing a sustainable supply, **enabling Europe to drastically decrease its dependency on REE imports**. This high-temperature electrolytic process enables **rare earth alloys to be directly produced from rare earth oxide mixtures without the need to separate the oxides first**. The **EU is currently 100% reliant on imports for REEs**, which come almost entirely from mines in China, and with the growing number of valuable applications, such as smart phones, laptops, and electric vehicles, **demand for REE is high**. However, if Europe wishes to support manufacturing growth, technological advancement and the transition to a low-carbon economy, it will need to **secure access to sustainably produced critical materials**.

Success Story 4: SPOTVIEW – Water Security and Savings Through Efficient Industrial Processes

Period: 03/10/2016 – 02/04/2020

Website: www.spotview.eu

Disruptive Impact: The innovations developed will reduce industry's freshwater consumption and wastewater **by up to 90% in the EU**. By 2030 the **global demand for freshwater will outstrip supply by 40%** due to population growth, rising living standards, and the expansion of irrigated agriculture and industry. To tackle the global water crisis, **industrial water (accounting for 10% of freshwater consumption in the EU) efficiency** needs to be improved.

Disruptive Innovation: The SPOTVIEW project is **demonstrating new 14 technologies**, as well as **9 innovative water management practices that can optimise industrial water processes**. These include: an **electrolytic biocontrol concept** that creates biocide from salts in process water; a **chemical heat pump** that uses low-temperature heat from wastewater

to heat processes; an **elevated pressure sonication** technology that purifies milk with less energy than pasteurization; and a **cross-rotational ultrafiltration process** that cleans water for reuse in paper tissue

mills, reducing freshwater consumption. Through this recovery of valuable resources, as well as reduced consumption of energy and chemicals, **industry will save €1.53 billion annually**.

2.3: ENABLING SUSTAINABLE INDUSTRY DEVELOPMENT

This overarching, horizontal topic has been implemented by two calls - **SPIRE-04-2014** (Methodologies, tools and indicators for cross-sectorial sustainability assessment of energy and resource efficient solutions in the process industry) and **SPIRE-06-2016** (Business models for flexible and delocalised approaches for intensified processing) - and resulted in four projects INSPIRE, MEASURE, SAMT and STYLE all now completed.

Success Story 5: SPRING – Setting the framework for the enhanced impact of SPIRE projects

Period: 01/09/2017 – 01/09/2019

Website: www.spire2030.eu/SPRING

Context: The SPIRE projects, of which there are now over 100, are delivering numerous results that are **rich in technologies, innovation and knowledge to address the SPIRE energy, resource and emissions targets**. The SPRING project is tapping into these results and other **diverse project output resources** (e.g. technology state-of-the-art reviews, demonstration media, data and surveys) **with great potential** to enable the EU Process Industries, academia and other relevant stakeholders, to **create disruptive innovations and enhanced impact** that could help **reduce fossil energy intensity and decrease dependency on non-renewable energy sources**.

Recommendation for Disruptive Impact and Disruptive Innovation: The project targeted **decision makers crucial for the**

adoption of process innovations in industry, looking specifically at their **needs and the barriers encountered**. Amongst other things, the project's recommendations underline **the importance of having platforms to facilitate access to project outputs across the SPIRE portfolio, reducing repetition of projects covering the same ground, robust methodologies for the selection of technologies to be exploited, and improved approaches to collecting and aggregation of impact data**.

The **implementation of such recommendations**, for example on the SPIRE website, where exploitable results and outputs from the SPIRE projects are made available, and through SPRING guidance and training modules focused on enhancing impact and improving decision-making, **will have enormous implications for the visibility and eventual adoption of disruptive innovations in the European marketplace**, and upon subsequent **disruptive impact** that stimulates the EU process industries in **achieving resource, energy and emissions savings**.





CHAPTER 3

CE-SPIRE-02-2018

DESTINY

LIBERATE

PERFORM

SIMPLIFY

DEVELOPMENT OF AN EFFICIENT MICROWAVE SYSTEM FOR MATERIAL TRANSFORMATION IN ENERGY INTENSIVE PROCESSES FOR AN IMPROVED YIELD



AIM

The project aims to realise a functional, green and energy saving, scalable and replicable solution, employing microwave energy for continuous material processing in energy intensive industries. The target is to develop and demonstrate a new concept of firing granular feedstock for materials transformation using full microwave heating as an alternative and complement to existing conventional production methods.

CONCEPT

The concept will be proved in two demonstration sites located in Spain and Germany, covering high energy demand sectors of strategic interest, such as Ceramic (Pigments), Cement (Calcined clay) and Steel (Sinter, Iron Pellets/DRI, ZnO), to validate the

critical parameters of the developed technology in a relevant industrial environment (TRL 6). It will be implemented through two feeding modules per site and one mobile microwave kiln module and product treatment.

The influence of DESTINY solutions in terms of stability, process efficiency and characteristics of raw materials, intermediate, sub- and final products will be investigated to improve performance of the industrial processes addressed and guarantee the required quality of the final products. Numerical simulation tools will be used to drive the design and support the testing activities.

The industrialisation and sustainability of DESTINY high temperature microwave technology will be assessed through the evaluation of relevant KPIs with Life Cycle Methodologies.

WWW.DESTINYH2020ANDBEYOND.EU

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 820783.



LIGNIN BIOREFINERY APPROACH USING ELECTROCHEMICAL FLOW



AIM

Liberate aims to design an electrochemical plant to demonstrate the commercial opportunities for converting low cost lignin feedstock into high value biosustainable chemicals such as vanillin, antioxidants and polyamide.

CONCEPT

Liberate applies highly efficient and selective anodic electrochemical oxidation to the depolymerisation of lignin and the synthesis of propyladipic acid from cyclohexanol. This will deliver a range of biosustainable feedstocks for drop in replacements or for superior product performance.

Liberate works on four objectives:

- Electrochemical depolymerisation of kraft lignin to synthesise vanillin with a 7% yield.
- Electrochemical depolymerisation of organosolv lignin to synthesise mixed phenolic derivate oligomers with a yield of > 35%.
- Electrochemical oxidation of biosustainable cyclohexanol derivatives to synthesise propyl adipic acid with a yield of up to 80%.
- A biorefinery process that is capable of accommodating renewable energy fluctuations without loss in efficiency, exhibits a 95% improvement in the energy efficiency of the process and 350% improvement in resource efficiency, and produces 29 times less CO₂ than the conventional petrochemical alternatives.

WWW.LIBERATE-PROJECT.EU

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 820735.



POWER PLATFORM



AIM

PERFORM aims at developing highly efficient and integrated electrochemical systems which will substantially improve sustainable production of valuable building blocks from bio-based feedstocks. The project will reduce the environmental impact of chemical production by lowering CO₂ emissions and will contribute as well to the future of sustainable society using local resources.

CONCEPT

This consortium led by TNO (The Netherlands) and formed by VITO (Belgium), Avantium (The Netherlands), INSTM (Italy), Gensoric (Germany), Hysytech (Italy), Sustainable Innovations (Spain), Perstorp (Sweden), Radici Chimica (Italy), AVA Biochem (Switzerland), University of Hohenheim (Germany) and Novamont (Italy) will work for

48 months in order to develop and build an electrochemical pilot reactor, a direct conversion to the targeted products.

For this purpose, TNO, VITO and Hysytech will construct a flexible PowerPlatform pilot plant in order to demonstrate technologies and innovations, leading to the implementation of more sustainable electrochemical processes. PERFORM pilot plant will continue to serve after the project, as a platform to validate innovative electrochemical process routes. The other consortium parties will support the project with research.

WWW.PERFORMPROJECT.EU

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 820723



SONICATION AND MICROWAVE PROCESSING OF MATERIAL FEEDSTOCK



AIM

In today's chemical process industry batch production is the standard despite high energy consumption, waste of resources and heavy costs. SIMPLIFY aims at reducing these expenditures by developing and validating continuous production ensured by the application of alternative energy forms: microwave and ultrasound.

CONCEPT

SIMPLIFY focuses on intensified processes, where alternative energy sources enable flexible continuous technologies to achieve localised ultrasound and microwave actuation of multiphase flow reactors powered by electricity from renewable sources for the purpose of high-value


product synthesis. At the core of SIMPLIFY are three case-studies serving as representatives for process classes of high importance in the chemical industry: one in the domain of reactive extrusion, the other two in the domain of reactive crystallisation. Each of these case-studies is of interest to one industrial end-user in the project. The three case-studies are supported by both generic and applied research on the enabling technologies: ultrasound, microwave and process control. In addition to the process technology-oriented activities, the sustainability and techno-economic improvement of the transition from batch process to an ultrasound/ microwave-assisted continuous process are investigated.

WWW.SPIRE2030.EU/SIMPLIFY

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 820716.





"SPIRE is the driving force for sustainable process industries to listen and learn, plan and do, check and act. Especially in Europe's focal area of resource and energy efficiency, embedded in a lower-carbon and more circular economy, SPIRE projects create valuable partnerships and build new capacities."

INEOS
THE WORD FOR CHEMICALS

CHAPTER 4

CE-SPIRE-03-2018

BAMBOO

CIRMET

PreMa

iCAREPLAST

BOOSTING NEW APPROACHES FOR FLEXIBILITY MANAGEMENT BY OPTIMISING PROCESS OFF-GAS AND WASTE USE

BAMBOO

AIM

BAMBOO is expected to demonstrate energy and materials demand management concepts in highly intensive industries relying on the valorisation and reuse of waste streams.

It is expected to show an increase in the overall process energy efficiency of about 18%. A percentage obtained as an average value of the integrated solution energy savings estimated for each demo site (AMII, TUPRAS, UPM and GM).

CONCEPT

Due to its significant resource use, its waste and emissions, heavy industry has for many years been seen as an obstacle to sustainable development. But this is not the full story.

Today the energy intensive industries (REII) must adapt their current consumption and production patterns to a higher share of renewable energy supply.

BAMBOO is an EU-funded project developing new technologies for energy and resource efficiency challenges in four intensive industries. These technologies will be adapted, tested and validated under real production conditions and focus on three main innovation pillars: waste heat recovery, electrical flexibility and waste streams valorisation.

BAMBOO will provide the industries with the information they currently lack for the adaptation of their processes to new and more advanced industrial demand response schemes to help them make better decisions and to increase their competitiveness.

WWW.BAMBOOPROJECT.EU

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under Grant Agreement N°820771.



INNOVATIVE AND EFFICIENT SOLUTION, BASED ON MODULAR, VERSATILE, SMART PROCESS UNITS FOR ENERGY AND RESOURCE FLEXIBILITY IN HIGHLY ENERGY INTENSIVE PROCESSES



AIM

CIRMET aims to develop and validate an innovative and efficient solution for the energy intensive processes industries for energy and resource flexibility, which follows a near-to-zero waste circular economy approach. It is an innovative and holistic approach based on a flexible and modular metallurgical furnace, gas heat recovery and transformation into compressed air, and finally controlled and optimised through an advanced data analytic platform.

CONCEPT

The CIRMET concept is based on the combined implementation of innovations on the reuse of raw materials and waste valorisation, energy efficiency

through sustainable energy sources and heat recovery, and finally smart monitoring, control and data analytics.

The CIRMET solution is composed of (1) a metallurgy furnace for recycling and valorisation of industrial wastes, (2) a heat recovery system for adapting the continuous generation of mechanical energy by industrial consumption of electricity, and (3) a monitoring platform to improve process plants competitiveness, by ensuring the best mix between raw materials and by-products to maximise final product repeatability (productivity) and waste re-valorisation. Due to its flexibility, this solution will be at least 15% more efficient than existing solutions. The CIRMET solution are going to be built and integrated in a flexible, modular and versatile process unit: the CIRMET unit.

The complete validation of the CIRMET solution will be done through the treatment of non-ferrous and steel process products in an existing retrofitted metallurgy furnace. A replicability study for evaluation of the adaptability of the CIRMET unit into further different energy intensive industries (cement, engineering, water) will also be performed.

WWW.SPIRE2030.EU/CIRMET

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 820670.



ENERGY EFFICIENT, PRIMARY PRODUCTION OF MANGANESE FERROALLOYS THROUGH THE APPLICATION OF NOVEL ENERGY SYSTEMS IN THE DRYING AND PRE-HEATING OF FURNACE FEED MATERIALS



AIM

PREMA aims to develop and demonstrate an innovative suite of technologies involving utilisation of waste gas streams and solar technology approaches that allow the pre-treatment of manganese (Mn) ores while utilising more efficiently energy and material streams and thus decreasing direct and indirect CO₂ emissions.

CONCEPT

The main concept of PREMA consists of dividing the current Mn-alloy production process in submerged arc furnaces into a two-step process by adding a furnace feedstock pre-treatment unit for reduction of Mn ores from MnO₂ to MnO in the solid phase. For the pre-treatment, novel sustainable energy

systems for drying and preheating of Mn ores using alternative energy sources, e.g. bio-carbon, CO₂ rich off-gas and concentrated solar thermal systems, will be developed and tested to substitute the currently used fossil fuels and electricity.

Integration of the PREMA pre-treatment technologies with the current processes will lead to improved flexibility in terms of raw materials leading to a 20% reduction in the consumption of fossil carbon, energy efficient production processes with a potential for a 20% reduction in overall energy consumption and a global reduction of operating costs by at least 10%.

WWW.SPIRE2030.EU/PREMA

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N° 820561.



INTEGRATED CATALYTIC RECYCLING OF PLASTIC RESIDUES INTO ADDED-VALUE CHEMICALS



AIM

iCAREPLAST addresses the cost and energy-efficient recycling of a large fraction of today's non-recyclable plastics and composites from urban waste. Heterogeneous plastic mixtures will be converted into valuable chemicals (alkylaromatic) via chemical routes. The project aims to demonstrate the full technology portfolio for plastic waste valorisation in a pilot plant able to process >100 kg/hour of plastic.

CONCEPT

iCAREPLAST will provide a cost-effective and energy-efficient process to up-cycle non-recycled plastic waste into alkylaromatics, used in the chemical industry for many applications, like production of solvents, surfactants or monomers.

Plastic mixtures will be converted into valuable alkylaromatics via chemical routes comprising sequential catalytic and separation steps. This multistage process will also yield carbon char and a pure CO₂ stream as products, whilst demonstrating improved economic sustainability, operational flexibility and lower CO₂ footprint thanks to (i) the energetic valorisation of gas by-products through innovative oxycombustion units integrated with efficient heat recovery; and (ii) the use of artificial intelligence (AI) predictive control and real time optimisation. Advanced upstream waste sorting, pre-treatment and pyrolysis is strongly backed by previous demonstration activities and knowhow within the project consortium including profound knowledge of the waste management and recycling market.

The iCAREPLAST solution will reinforce circular economy by substantially increasing the amount of recycled plastics to produce commodity products that can be used as in virgin-quality polymer production or as raw materials for other processes.

WWW.ICAREPLAST.EU

DISCLAIMER

This project has received European Union's Horizon 2020 research and innovation funding under Grant Agreement N° 820770.





IONIC SOLVENT-BASED RECYCLING OF POLYPROPYLENE PRODUCTS



AIM

ISOPREP is joining the battle against plastic pollution by developing a solvent-based recycling technology that targets waste polypropylene products. The technology aims to generate polypropylene resin that has a quality analogous with that produced directly from fossil fuel resources.

CONCEPT

Polypropylene (PP) is a fossil fuel derived polymer used in a wide variety of products. Currently only 1% of waste PP is recycled with the rest ending in landfill, making it a substantial contributor to non-biodegradable plastics contamination of the environment. The current recycling methods for PP mainly rely on mechanical processing, which generally results in an impure product that can only be used for lower value applications and is therefore 'down-cycling' rather than true recycling.

The purpose of ISOPREP is to design a commercially viable process to recycle waste PP, specifically end of life carpet, back to a 'virgin' quality resin rendering it completely suitable for re-use in high value applications. ISOPREP is taking a novel patented solvent-based PP recycling technology that has been developed and proven in the laboratory (TRL5), and demonstrating it at pilot plant scale (TRL7).

WWW.ISOPREP.CO.UK

DISCLAIMER

The research project ISOPREP receives funding from the European Community framework Programme for research and innovation under the Horizon 2020 (2014-2020) Grant Agreement N° 820787.



SECOND GENERATION METHYL METHACRYLATE



AIM

The MMAtwo Project aims to construct a new PolyMethylMethAcrylate (PMMA) recycling value chain based on the production of Second Generation MethylMethAcrylate (MMA) from post-consumer and post-industrial PMMA waste. This will be accomplished by the joint development of an innovative recycling technique and supporting processes to depolymerise contaminated PMMA wastes without the use of lead for reuse in high end applications.

CONCEPT

PMMA is a well-established polymer known for its optical properties. It is used in signage, automotive lighting, construction domes, aquaria, sanitary products, display, electronic screens and many other industries. About 300,000 tons of PMMA are produced in Europe every year, worth close to one billion EUR. Although PMMA can be turned back into its monomer by thermal depolymerisation, with huge savings on resources such as energy, water and CO₂ emission, it is estimated that currently only 30,000 tons of PMMA waste from Europe is recycled annually. Of this less than 7,000 tons are recycled within Europe, less than 2.5%, of the annual European production. As with many polymers, there is a lack of good quality recycling

capacity for PMMA waste within Europe, which has become a more pressing problem since China, India and other Asian countries closed their borders to polymer waste. A significant proportion of PMMA recycling is currently reliant on a lead-based process which is not able to reprocess lower PMMA qualities. PMMA waste's current recycling processes focus on postindustrial PMMA, rather than end-of-life PMMA which represents the main share of the total PMMA waste stream, which is currently either exported, sent to landfill or incinerated.

MMAtwo will bring high quality recycling capacity for PMMA waste to Europe. MMAtwo's innovative concepts for PMMA waste recycling through depolymerisation will focus on handling both postindustrial and contaminated end-of-life PMMA waste, thereby converting difficult to recycle waste, that would otherwise be sent to landfill or incinerated, into high quality secondary raw material. To achieve this also requires the optimisation of sub-processes in the recycling chain such as the effective collection of end-of-life PMMA waste. The PMMA recycling process will be validated at TRL7, enabling the possibility of a first commercial unit soon after the end of the project in 2022.

MMAtwo is supported by a consortium of 13 partners from six countries each representing a step in the PMMA waste value chain. Besides developing a new concept for PMMA recycling, MMAtwo will also create a new value chain for PMMA waste in which producers, waste collectors, processors, end-users and the academic community all work together to accomplish a streamlined recycling of European PMMA waste whilst establishing a business model that can be exploited across other continents as well.

WWW.MMATWO.EU

DISCLAIMER

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ADVANCED & SUSTAINABLE RECYCLING PROCESSES AND VALUE CHAINS FOR PLASTIC-BASED MULTI-MATERIALS



AIM

As part of the shift to a Circular Plastics economic model, MultiCycle will deliver an industrial recycling pilot plant for fossil and bio-based thermoplastic multilayer packaging and fibre reinforced composites using a novel solvent-based selective extraction process, which allows recovery of pure plastics and additives from mixed wastes for reprocessing into value-added applications.

CONCEPT

Plastics deliver value in consumer products and high-end applications, but single-use, linear consumption is unsustainable, and recycling complex multi-materials is challenging. The MultiCycle industrial recycling pilot plant, based on the patented CreaSolv® process (CreaSolv® is a

trademark registered by CreaCycle GmbH), will be demonstrated in two important industrial segments, multilayer packaging / flexible films and automotive fibre-reinforced thermoplastic composites, as indicators for many other segments.

The selective, versatile extraction process is being taken to unprecedented scale, optimised and digitised for industrial readiness (TRL 7). Pure plastics and fibres recovered will be processed and formulated in place of virgin resources to target at least fourteen different packaging, composite/textile semi-finished and final demonstrators. The new process impacts will be confirmed by techno-economic feasibility and environmental, social and economic sustainability evaluation.

WWW.MULTICYCLE-PROJECT.EU

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 820695.



DEMONSTRATION OF INNOVATIVE TECHNOLOGIES TOWARDS A MORE EFFICIENT AND SUSTAINABLE PLASTIC RECYCLING



AIM

The main objective of polynSPIRE is to demonstrate a set of innovative, cost-effective and sustainable solutions, aiming to improve the energy and resource efficiency of post-consumer and post-industrial plastic recycling processes, targeting 100% waste streams containing at least 80% of plastic materials.

CONCEPT

By applying three innovative pillars (chemical recycling, advanced additivisation and high energy irradiation to enhance recycled plastics quality, and valorisation of plastic waste as a carbon source in the steel industry), the project can lead to a reduction of up to 34% in fossil fuel use for polyamides production and 32% for polyurethanes.

In addition, reductions of around 80% for fossil carbon sources in electric arc furnaces are expected.

The demonstration will be completed by the performance of a rigorous holistic environmental and economic analysis (LCA and LCC) to ensure the industrial feasibility and the accomplishment of environmental restrictions. Efforts are dedicated to analyse non-technological barriers (legislative and standardisation) that could hinder the appropriate deployment of the developed innovations.

polynSPIRE also implies the development of a comprehensive business plan, gathering seven business models and establishing a cross-linked relation between plastic, chemical and steel manufacturing industries.

WWW.POLYNSPIRE.EU/

DISCLAIMER

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“SPIRE provides additional value over the Horizon 2020 programmes by facilitating cross sector collaboration”





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