



Power to your know-how



“Despite the COVID pandemic, 2020 has been another prolific year for SPIRE and A.SPIRE and its critical contributions to the resource and energy efficiency of European process industries. Our expanding cross-sectorial, cross-disciplinary and cross-border initiative continued to bear tangible, practical fruit, while at the same time, it metamorphoses into our new, more ambitious, more impactful Partnership under Horizon Europe: Processes4Planet.

I and my colleagues on the A.SPIRE Board look forward with growing enthusiasm to this immense opportunity to, on one side, build on the learnings of SPIRE's unprecedented seven-year partnership and, on the other side, step-up our ambition and develop, with the support of the European Commission, the disruptive Process Industry solutions required for a successful transition of our Industries to the climate neutral and truly circular society we must achieve. Our proud contribution to the Green Deal, support a just recovery, and catalyse a sustainable European industrial strategy!”

Pierre Joris,  
A.SPIRE President



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# CHAPTER 1

Introduction

## 1.1: ABOUT A.SPIRE

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A.SPIRE aisbl is an international non-profit association led by the EU Process Industry that has managed, from the private side, the Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) contractual Public-Private Partnership (cPPP). It gathers members from the whole innovation chain: top priority of the Association at the moment is to enable these members to work together towards the high ambitions of the new Processes4Planet Partnership.

SPIRE Partnership was launched in 2013 as part of the European Union's Horizon 2020 Research and Innovation framework programme and its successor, Processes4Planet co-programmed Partnership, will be a significant player in the recently launched Horizon Europe programme.

From its initial 28 founding members in 2012, A.SPIRE has grown continuously and expanded its activities. Today, in 2021, A.SPIRE is a diverse community of more than 180 members including large industries, SMEs, industrial associations, research organisations and institutions, academia, regional agencies and many other stakeholders.



A.SPIRE now covers ten European process industry sectors: cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, pulp and paper, refining, steel and water.

A.SPIRE is a unique meeting place and forum for the sustainable development of European process industries. It has inspired an unceasing dialogue between A.SPIRE members enabling the multiple and various process industry sectors to come together, share experiences, methodologies and technologies and address common challenges. This unique ability to organise across multiple world-leading industrial sectors operating throughout Europe and globally, and to include large and small businesses, research and innovation organisations, means that A.SPIRE's strategies and initiatives are broadly based, inclusive and its results aim to be implementation-ready.

This ensures that A.SPIRE and its SPIRE public private partnership and Processes4Planet Partnership can effectively support the achievement of EU policy objectives such as climate neutrality and establishing a circular economy in Europe. Indeed, it is clear that the significant challenges that society faces cannot be tackled without the commitment and expertise of industry – and the process industries in

particular. Moreover, the Association provides a bottom-up and systemic approach that can deliver much more for society than individual, unconnected initiatives.

A.SPIRE's expertise and cross-sector connections will be particularly useful as Europe looks to 'build back better' following the COVID-19 pandemic and achieve a just and sustainable recovery while also addressing the targets set out under the European Green Deal. We share the Commission's aspiration for Europe to become the first climate-neutral continent and are ready to transform and evolve our own processes and programmes to ensure that we can help enable the research and innovation initiatives and structural changes required to deliver a climate-neutral and competitive economy and society - and realise the European Green deal.

We look forward to continuing collaboration and contributions to achieve these aims from all A.SPIRE sectors and members whether they are old hands, new participants, or yet to join us!

### **Completing and enhancing the SPIRE story**

The 30 projects described in this 2020 SPIRE projects brochure will be the last projects launched and coordinated by SPIRE under the European Commission's Horizon 2020 research and innovation programme.

Since the SPIRE contractual Public-Private-Partnership (cPPP) was launched in December 2013, it has inspired and initiated almost 50 programme calls under Horizon 2020. Between 2014 and 2020 these calls have covered topics including efficient processes, the circular economy, and the development of technologies and innovations that enable a wide range of sustainable industrial development.

In total, SPIRE, through Horizon 2020, has supported more than 140 research and innovation projects. SPIRE projects are already delivering results that are improving European competitiveness, jobs and growth, action on climate change and environmental protection.

But A.SPIRE wants to do more. In the medium- to long-term the innovations developed through the SPIRE will enable the emergence of a truly sustainable European economic system in which economic growth is permanently decoupled from environmental impact and leading to an industrial infrastructure that can deliver a climate-neutral continent.

The ambitious A.SPIRE Vision for 2050 published in 2019 foresaw "An integrated and digital European Process Industry, fostering a 'well below 2°C' scenario and fully circular economy."



## About A.SPIRE

This A.SPIRE Vision 2050 emerged from intense consultation and dialogue between A.SPIRE stakeholders on their shared research and innovation requirements, their joint challenges and wider societal needs.

In the A.SPIRE Vision 2050 Energy and Resource Efficiency remained the core focus areas for research and innovation activities with digitisation helping to accelerate the transition. These core technologies will lead the sustainable reindustrialisation of European Process Industry with multiplier effects generated across the economy. Innovative “industrial ecology” business models will be developed building sustainable physical and digital bridges across sectors and between states and regions.

The EU Process Industries can become Hubs for Circularity for energy and material resources, deploying industrial and urban symbiosis at scale in close collaboration with public authorities and society.

SPIRE Vision 2050 have been further elaborated into the Processes4Planet 2050 Strategic Research & Innovation Agenda (SRIA) - a multiannual and dynamic industry-led strategy that addresses critical research and innovation activities through widespread cross-sectorial collaboration.

The SRIA builds on the experience and results gained in SPIRE's Horizon 2020 projects and looks to develop the next generation of process technologies that can realise our ambitions for 2050:

- Climate neutrality: towards climate neutrality in 2050
- Circularity of resources: near-zero landfilling and near-zero wastewater discharge in 2050
- Competitive process industries: the innovations contribute to the EU process industry's GVA growing quicker than EU GDP.

“In the last 7 years, SPIRE cPPP has achieved many successes and paved the way for the systemic change Processes4Planet co-programmed Partnership strives for. The outstanding SPIRE projects and A.SPIRE members have been the true makers of these successes. We want to acknowledge the key role of this brilliant community of actors for change. Building on the outcomes of the last 7 years, A.SPIRE community will accelerate the path towards even more ambitious targets with Processes4Planet for a prosperous society.”

**Àngels Orduña Cao,**  
**A.SPIRE Executive Director**

## 1.2: PROCESSES4PLANET: THE NEXT STEP

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PROCESSES4PLANET

Processes4Planet will take resource and energy efficiency in the process industries to the next level.

Building on the success and collaborative actions of SPIRE, the Processes4Planet partnership will be the unique cross-sectorial research and innovation initiative required to develop and deploy the innovations needed for a profound transformation of the European process industries and achieve overall climate neutrality at EU level by 2050 - while also enhancing Europe's global competitiveness.

Processes4Planet will work on new technologies and on the scaling up of technologies already developed to deliver significant CO2 emission reductions by 2030 and to achieve full impact by 2050.

The Processes4Planet programme will work through Horizon Europe calls and use a blended finance approach to mobilise further funding beyond Horizon Europe for demonstration and deployment activities at higher, near-market TRLs.

A special focus of the Processes4Planet partnership will be to foster local innovation initiatives through 'Hubs for Circularity' where local public authorities, process industries and other private actors will work together to design and implement integrated business models maximising the circularity of resources and minimising impacts on the environment.

The partnership will also scale-up innovations to practical industrial dimensions through "first-of-a-kind" plants (aka 'Marbles'), de-risking investment decisions for subsequent widescale roll-out.

The potential of digital technologies and of social innovation will be fully exploited and recommendations will be made on the changes required in regulations and incentives to enable industrial-scale deployment and market uptake.

A pro-active and continuous engagement with Member States, Regions, other partnerships and Initiatives and other relevant stakeholders is crucial to generate the required change. Processes4Planet will create mechanisms to ensure that engagement and dialogue are built into its planned activities and enable the maximum impact for our planet and people.

## Processes4Planet Partnership

The Process Industry is committed to contribute to reach Europe's Climate Neutrality and Circular Economy goals, but the challenge and the extent the transitions required in society over the next decades are unprecedented. The COVID-19 pandemic has enhanced these challenges.

The new Processes4Planet 2050 Strategic Research & Innovation Agenda (SRIA) outlines the proposed Innovation Programmes that will be largely implemented through Horizon Europe. The Processes4Planet SRIA builds on the A.SPIRE vision of 10 Sectors integrated in one large industrial-urban ecosystem and highlights three challenges:

- High impact on Climate
- Linear Business Models
- Global Competitiveness & Investment

These will be tackled via three pathways for impact standing on A.SPIRE ambitions. In this scenario process industries will:

- Redesign industrial processes and rethink their interaction with the energy system
- Develop and deploy sustainable circular business models through technological and non-technological innovations, cross-sectoral collaboration and engagement with the local ecosystem
- Foster economically attractive solutions, strengthened integration in the economic fabric of regions and Member States, reliable investment agenda.

Relevant funding will be necessary to reach these goals. An estimated total of at least €35 billion of investment up to 2050 will be required to develop and progress this extremely ambitious pipeline of innovation.

European process industries stand on the brink of a great transformation to become circular and climate neutral by 2050. A.SPIRE and Processes4Planet's unique collaborative approach can deliver the cross-sectorial innovation that is essential for this profound transformation.



## 1.3: JOIN A.SPIRE

A.SPIRE aisbl is an international non-profit association that represented the private sector in the Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) contractual Public-Private Partnership (cPPP) and that is now committed to manage and implement the Processes4Planet co-programmed Partnership. Processes4Planet will be a significant player in the recently launched Horizon Europe programme.

With more than 180 industrial and research industry members, A. SPIRE is enabling its members to address the challenges of Climate Change, the Circular Economy, sustainable competitiveness and post-COVID recovery by:

- Helping to shape the future of the process industry and address its research and innovation needs by defining and implementing roadmaps and joint actions across Europe.
- Joining the 10 sectors to co-define the business opportunities triggered by research and innovation outcomes that can support the Green Deal objectives.
- Enabling networking across major industry sectors to find partners and opportunities through our member-only brokerage workshops and other targeted activities.
- Accessing knowledge on technological and non-technological developments in the A.SPIRE community, sharing best practices and relevant funding opportunities, and enabling direct access to SME providers, applied innovation, growth opportunities and new markets.
- Improving member visibility across diverse sectors and enabling them to contribute to the Green Deal debate and providing publicity opportunities through the A.SPIRE website, events, and publications at European and national levels.

Three types of A.SPIRE membership are available: Industry Membership (open to industrial and commercial companies, trade associations or any other type of industrial association, cluster, federations or coalitions active in the field of process technologies and process manufacturing in general); Research Membership (open to research institutes and universities active in the field of process technologies and process manufacturing in general); and Associate Membership (a non-voting category open to trade associations, nongovernmental organisations and other stakeholders that have an interest but are not playing an active role in process technology and process manufacturing).


Membership of A.SPIRE is only open to legal entities established in European countries and all applications must be approved by the A.SPIRE Board.

Together, we can enable Europe to lead the next generation of process industry globally, and become the first climate-neutral continent.

Be part of your future, learn more about the Membership on A.SPIRE website and apply today!





An aerial photograph of a dense green forest. A light blue, winding river or stream flows through the center of the forest, creating a complex, meandering path. The water reflects the surrounding greenery. A large, white circular graphic with a green border is positioned in the lower-left quadrant of the image, containing text and a logo.

“IRIS S.L. as an engineering SME specialised in real-time process monitoring and digitalisation, our membership of A.SPIRE affords us first-hand visibility and understanding of the technological and innovation requirements of the European Process Industries, and is a unique opportunity to engage with and co create solutions with key industrial players.”







## ACCELERATING WATER SMARTNESS IN COASTAL EUROPE

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### AIM

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The water sector in coastal areas is facing challenges such as water scarcity and increasing water demands due to climate change or economic/population growth. This leads to overexploitation of resources, quality deterioration and regional imbalances in water availability. To tackle these challenges, the B-WaterSmart project is developing and demonstrating smart technologies and circular economy approaches.

### CONCEPT

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To implement smart solutions and circular economy approaches more strongly in the practice of the water sector, technical and digital solutions as well as new business models are being jointly developed by the project partners. The aim is to accelerate the transformation to water-smart economies and societies in European coastal regions and beyond by reducing the use of freshwater resources, improving the recovery and reuse of resources, and increasing water use efficiency.

The research is based on specific issues in six European coastal cities and regions that have great ambitions to tackle their challenges and promote opportunities by implementing water-smart technology and management solutions. Water companies from Alicante in Spain, Bodø in Norway, Flanders in Belgium, Lisbon in Portugal, East Frisia in Germany and Venice in Italy will develop and demonstrate solutions as Living Labs, together with research partners and local technology providers.

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[WWW.B-WATERSMART.EU](http://WWW.B-WATERSMART.EU)

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### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869171.



## WIDER UPTAKE OF WATER-SMART SOLUTIONS



### AIM

The aim of WIDER UPTAKE is to facilitate industrial symbiosis to increase resource efficiency, limit emissions and develop sustainable business based on water-smart solutions. The overall objective is to co-develop a roadmap for widespread implementation of water smart symbiotic solutions for wastewater reuse and resource recovery, based on the principles of the circular economy.

[WWW.WIDER-UPTAKE.EU](http://WWW.WIDER-UPTAKE.EU)

### CONCEPT

WIDER UPTAKE will demonstrate innovative solutions that optimize water reuse, resource recovery and energy utilisation where market utilisation of the recovered resource(s) is achieved through a symbiosis between the water utility and industry. The case studies will provide applied knowledge on operationalization of the solutions that will be shared and further co-developed in a community of practice.

The demonstrations are: Wastewater reuse for agriculture and urban greening (Italy, Ghana, and Czech Republic); Phosphorus recycling, biogas, and biochar utilization (Norway, Italy, and Ghana); and Production of bio-composites for manufacturing materials with resources recovered from the whole water cycle (Netherlands).

WIDER UPTAKE's hypothesis is that the barriers for wider uptake of water-smart solutions are not only technological but also of an organizational, regulatory, social, and/ or economic character. WIDER UPTAKE will identify and demonstrate common measures for wider uptake through activities including Monitoring and control of health and quality risks; Circular-economy and efficiency potential; Governance and business models for industrial symbiosis; and Measuring water smartness and progress towards Sustainable Development Goals (SDGs).

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869283.



## INDUSTRY WATER-UTILITY SYMBIOSIS FOR A SMARTER WATER SOCIETY



### AIM

ULTIMATE aims to become a catalyst of a particular type of industrial symbiosis termed “Water Smart Industrial Symbiosis” (WSIS). Water and wastewater play a key role, both as a reusable resource, and as a vector for energy and materials to be extracted, treated, stored and reused within a dynamic socio-economic and business oriented industrial ecosystem.

### CONCEPT

ULTIMATE will develop and demonstrate systemic inter-linkages in nine high-profile case studies in Europe and Israel, covering the agro-food processing industry, the beverages industry, the heavy chemical/petrochemical industry and biotech industry. ULTIMATE will assess technologies and apply digital support tools to improve systemic interlinkages, develop innovative valorisation schemes through business models and symbiotic arrangements. It will promote business transformation to WSIS through active stakeholder engagement and co-creation, reduce barriers through novel governance approaches and best practice guidelines, thereby supporting the transition to a Circular Economy and implementation of EU policies. Within ULTIMATE ‘hubs for circularity’ clusters will be created, as targeted within the SPIRE 2050 Vision for Industrial Symbiosis, and the public understanding and interest required to achieve long lasting change in both the society and the economy will be established.

[WWW.ULTIMATEWATER.EU](http://WWW.ULTIMATEWATER.EU)

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 869318



## NEXT GENERATION WATER-SMART MANAGEMENT SYSTEMS: LARGE SCALE DEMONSTRATIONS FOR A CIRCULAR ECONOMY AND SOCIETY



### AIM

The Water Mining project aims to provide for real-world implementations of the Water Framework Directive (and other water legislation), incorporating Circular Economy and EU Green Deal packages, by showcasing and validating innovative next generation water resource solutions at pre-commercial demonstration scale. The project will connect sectors, value chains and relevant stakeholders to achieve holistic innovations.

[WWW.WATERMINING.EU](http://WWW.WATERMINING.EU)

### CONCEPT

Water Mining is a multidisciplinary research project that creates water management solutions using a circular economy approach. The consortium consists of 38 public and private partners and four linked third parties from 12 countries, led by the Delft University of Technology. Pilot sites will be in Cyprus, Spain, Portugal, Italy and the Netherlands to demonstrate new, sustainable and efficient ways to reclaim nutrients, minerals, biopolymers, energy and freshwater from desalination, and industrial and urban wastewater. To successfully integrate these value-added products into resource supply chains, the project will engage with communities of practice and produce science-based, market-oriented policy recommendations, design circular business models, and engage with stakeholders, leading to sustainable management of water resources.

Water Mining builds on the results of a previous SPIRE project Zero Brine (Re-designing the value and supply chain of water and minerals: a circular economy approach for the recovery of resources from saline impaired effluent (brine) generated by process industries). Both projects include demonstrations for circular economy solutions in process industries, with one of the largest demonstrations being implemented in the petrochemical cluster in and around Rotterdam Port.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869474.



## RESILIENT WATER INNOVATION FOR SMART ECONOMY



### AIM

The aim of REWAISE is to create a new “smart water ecosystem” that will result in a carbon free, sustainable hydrological cycle. In line with the concept of a resilient circular economy, REWAISE will recover energy, nutrients and materials from water in real operational environments, implementing technological innovations and new water governance methods with a network of nine living labs in five countries.

[WWW.REWAISE.EU](http://WWW.REWAISE.EU)

### CONCEPT

REWAISE will generate the full Value of Water, considering three key technical, economic and social factors:

- **Value in water**, by extracting minerals from seawater brine, recovering nutrients from wastewater, and converting all organic matter and biomass into energy.
- **Value from water**, developing the business of sustainable services and innovative products all along the water cycle, working with start-ups and SMEs to give them privileged access to the large utility users.
- **Value through water**, generating wellbeing in society through stakeholder participation and new governance methods to maximize the positive effects of innovation for the users and the environment.

With its nine living labs, REWAISE will enhance social engagement, adapt normative barriers, and develop common digital tools in a holistic approach of a water-smart society. The concepts developed will be scalable and replicable to other utilities in Europe and worldwide, boosting new business and employment related to water.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869496.



# CHAPTER 3

LC-SC3-NZE-4-2019

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**FLEXNCONFU**

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## FLEXIBILIZE COMBINED CYCLE POWER PLANT THROUGH POWER-TO-X SOLUTIONS USING NON-CONVENTIONAL FUELS



### AIM

FLEXnCONFU will develop innovative, economical, viable and replicable power-to-X-to-power solutions to be integrated into existing and new power plants. The project will enable power plants to level their loads and un-tap their flexibility by converting electricity into hydrogen or ammonia that can be re-used in the same power plant to respond to varying grid demand and also reduce their environmental impact.

[WWW.FLEXNCONFU.EU](http://WWW.FLEXNCONFU.EU)

### CONCEPT

The use of alternative carbon-free fuels in existing power plants and a high penetration of renewable energy sources into the power transmission grid are required in order to meet the European Union 2030 and 2050 climate and energy goals. Combined-Cycle Gas Turbine (CCGT) plants are a crucial technology that can provide the required flexibility to compensate for the intermittency of renewable energy sources.

Within the FLEXnCONFU project, excess electricity produced will be converted in carbon-free fuels (H<sub>2</sub> or NH<sub>3</sub>) via P2X2P applications to level the power plant load. In turn, these carbon-free fuels will be locally re-used in the same power plant to respond to varying demand. A 1MW scale power-to-hydrogen-to-power system will be integrated in a real operational environment in Portugal at EDP's Ribatejo power plant. Meanwhile, in the Savona Smart Microgrid laboratory in Italy, a small-scale power-to-ammonia-to-power solution will be coupled with a micro gas turbine (mGT) modified to burn ammonia.

The new FLEXnCONFU layout will unlock the current situation of low operating-hours CCGT power plants by providing secure back-up and improving their flexibility and overall efficiency. It will also allow smoother operations, while reducing air pollutant emissions.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 884157.



# CHAPTER 4

CE-SPIRE-05-2019

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**REVAMP**

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## RETROFITTING EQUIPMENT FOR EFFICIENT USE OF VARIABLE FEEDSTOCK IN METAL MAKING PROCESSES



### AIM

The objective of the REVaMP project is to develop, adapt and apply novel retrofitting technologies to cope with the increasing variability of material and energy feedstocks and to ensure their efficient use. This will be demonstrated through a number of different use cases from electric and oxygen steelmaking, to aluminium refining and lead recycling. The performance and benefits of the technologies will be assessed and quantified.

[WWW.REVAMP-PROJECT.EU](http://WWW.REVAMP-PROJECT.EU)

### CONCEPT

Existing metal production plants need to be retrofitted with appropriate sensors, for efficient characterisation of metal scrap in terms of their chemical composition analysis and for furnace operation, to cope with the varying conditions of the feedstock regarding materials and energy. Furthermore, the selection of the optimal feedstock in terms of material and energy efficiency must be improved by application of appropriate process control and decision support tools. Also, solid scrap preheating systems operated with waste derived fuel can increase the energy efficiency of the melting processes. To monitor and control the process behaviour in an optimal way, model-based software tools will be developed and applied.

The developed retrofitting solutions will be evaluated in terms of economic and ecological effects, as well as cross-sectorial applicability in other process industries. The project results shall be valorised, disseminated and exploited for the metal making sectors and process industry in general.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869882.





## COGNITIVE AUTOMATION PLATFORM FOR EUROPEAN PROCESS INDUSTRY DIGITAL TRANSFORMATION



# capri

### AIM

CAPRI brings cognitive solutions to the Process Industry by developing, testing and experimenting with an innovative Cognitive Automation Platform (CAP) to enable progress towards the Digital Transformation. CAPRI will address a range of challenges that the Process Industry faces by developing and testing cognitive technologies. These cognitive solutions will be applied in planning, control, and operation to achieve higher quality, flexibility and performance of the process industry.

[WWW.CAPRI-PROJECT.COM](http://WWW.CAPRI-PROJECT.COM)

### CONCEPT

CAPRI project will develop and promote digital transformation through a Cognitive Automation Platform (CAP) involving a Reference Architecture with four levels of cognitive human-machine interaction and a set of reference implementations that are both commercial and open source. The CAP will coordinate a set of specific cognitive solutions at the various levels of functional organization of the proposed automation.

The CAP conceptualizes Smart IoT connection; Smart Events processing; Smart Knowledge modelling; and Smart Decision support.

Through a modular architecture, the CAP platform will support knowledge models, machine learning systems and different cognitive modules for planning, operation and control. It will further coordinate a set of specific cognitive solutions at the various levels of functional organisation of the automation (from planning to sensors) based on analysis of the different use cases involved in CAPRI.

The innovative technologies and the CAP platform will be validated and demonstrated in three use cases - all key actors in the process industry – namely the Steelmaking, Asphalt and Pharma Industries.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 870062.



# CHAPTER 6

LC-SC3-RES-7-2019

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**FRIENDSHIP**

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**ASTEP**

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### FORTHCOMING RESEARCH AND INDUSTRY FOR EUROPEAN AND NATIONAL DEVELOPMENT OF SHIP

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#### AIM

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The FRIENDSHIP project aims to demonstrate that solar heat can be a reliable, user-friendly, high quality and cost-effective resource to meet the heat requirements for industrial sectors such as Textile, Plastics, Wood, Metal and Chemicals. The project will rely on the expertise of a consortium including research centres, industry leaders, as well as technology and heat suppliers.

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[WWW.FRIENDSHIP-PROJECT.EU](http://WWW.FRIENDSHIP-PROJECT.EU)

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#### CONCEPT

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A range of different couplings of technological and control innovations will be investigated: optimization of heat transfer coefficients; coupling and reliability of different solar technologies; introduction of high-temperature heat pumps; combined heat storage bringing flexibility on both solar and process loops with guarantees of continuous operation as well as plug-and-play integration; thermal chillers for cooling demand; and smart control to ease operation of the overall installation in accord with relevant process specifications. The proposed systems will be able to supply both heat at temperatures up to 300°C and chilling down to temperatures of -40°C. In order to guarantee the replicability and scalability of the proposed demonstration, specific work will be carried out with world-class industries involved in the consortium (regulatory studies, financial incentive schemes, and local energy markets creation), with a specific focus on relevant users cases: industrial sites and parks in European countries where solar heat is currently underused.

#### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 884213.



## APPLICATION OF SOLAR THERMAL ENERGY TO PROCESSES

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### AIM

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The EU-funded ASTEP project aims to develop novel concept for solar heating for industrial processes. The project will combine a rotary Fresnel solar collector and thermal energy storage technology based on phase change materials (PCM). This innovative system will be able to cover a proportion of the process industry's heat demand at temperatures and latitudes where current designs have failed.

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[WWW.ASTEPPROJECT.EU](http://WWW.ASTEPPROJECT.EU)

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### CONCEPT

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ASTEP will create a new innovative Solar Heating for Industrial Processes (SHIP) concept focused on overcoming the current limitations of these systems. This solution is based on modular and flexible integration of two innovative designs for the solar collector, SunDial, and the Thermal Energy Storage system, integrated via a control system which will allow flexible operation to maintain continuous service. ASTEP will demonstrate its capability to cover a substantial part of the heat demand of the process industry at temperatures above 150 °C and for latitudes where current designs are not able to supply. Its modularity and compactness will also enable easy installation and repair with reduced space requirements, while most components can be sourced locally. The ASTEP's process integration will allow full compatibility with the existing systems of potential SHIP end-users. These aspects will provide a very competitive solution to substitute fossil fuel consumption. The concept will be tested at two industrial sites to demonstrate the projects objectives at TRL5.

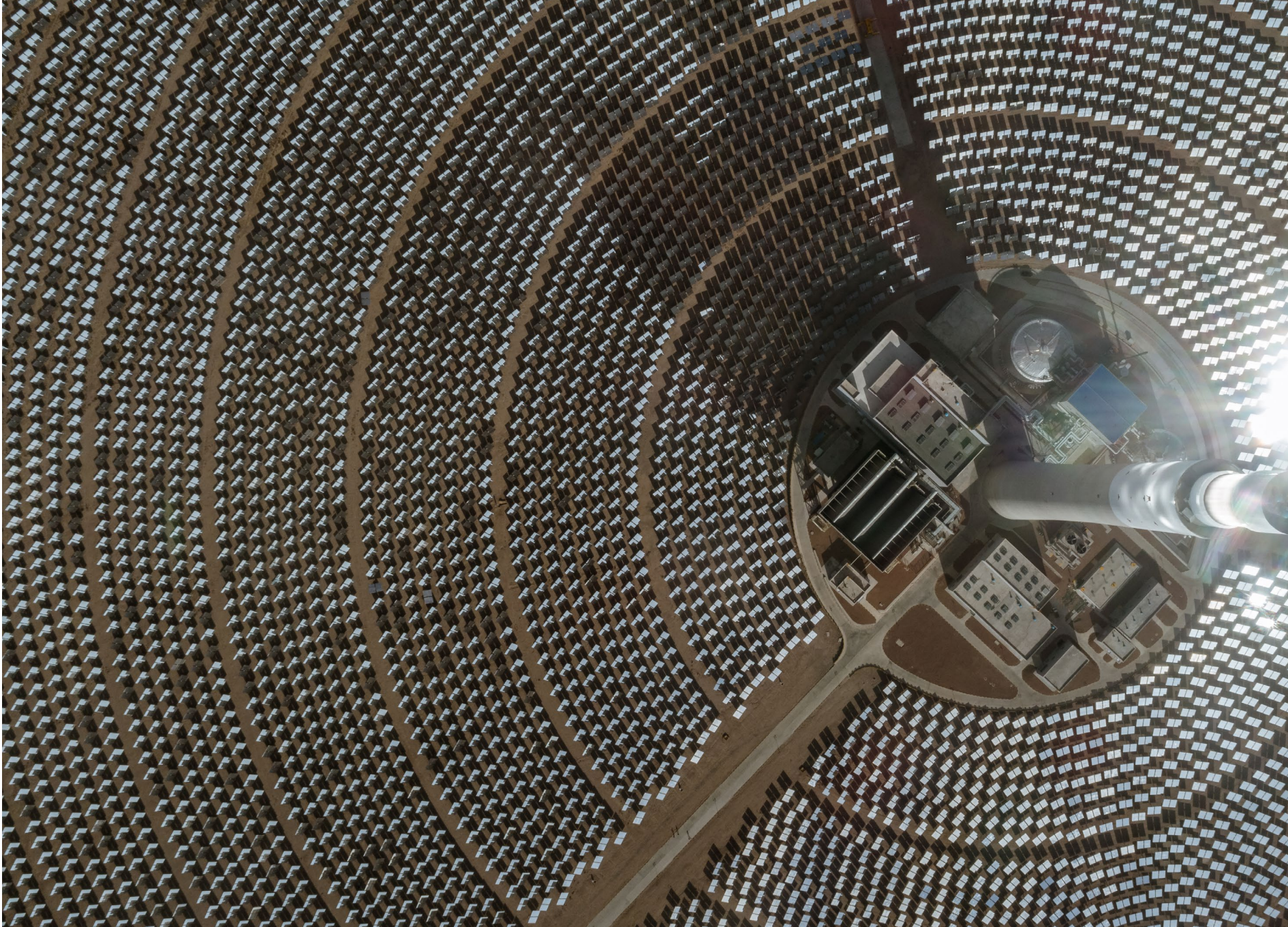
### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 884411.









# CHAPTER 7

CE-SPIRE-01-2020

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**INITIATE**

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**CORALIS**

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## INNOVATIVE INDUSTRIAL TRANSFORMATION OF THE STEEL AND CHEMICAL INDUSTRIES OF EUROPE



### AIM

To support emissions reduction in the iron and steel sector, INITIATE will demonstrate industrial symbiosis by converting carbon-rich residual steel gas into valuable products. This TRL7 demonstration project combines the production of  $N_2+H_2$  and  $CO_2$  streams, with innovative ammonia production as a precursor for urea synthesis. Ultimately, INITIATE will develop a commercial deployment roadmap for technology roll-out.

[WWW.INITIATE-PROJECT.EU](http://WWW.INITIATE-PROJECT.EU)

### CONCEPT

Steel making produces carbon-rich residual gasses that are generally used for power production. The INITIATE project demonstrates industrial symbiosis by using Basic Oxygen Furnace gas from the steel industry as a feedstock for ammonia production: the pre-cursor for urea. The concept sustains the cost of carbon capture, leading to a cost efficient decarbonization strategy. The energy and carbon from the residual stream are transferred to ammonia and urea production while effectively capturing the surplus carbon.

The INITIATE consortium consists of major steel and chemical industrial players (Arcelor Mittal, SSAB, Stamicarbon and NextChem), material suppliers (Johnson Matthey and Kisuma Chemicals), research organizations (TNO, SWERIM, Politecnico di Milano and Radboud University Nijmegen) and promoters of Carbon Capture and Use (CCU), circularity and industrial symbiosis topics (CO2 Value Europe). INITIATE demonstrates a novel symbiotic and circular process to transform residual steel gases into urea for subsequent use as a source for fertilizer and products such as AdBlue fuel additives.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958318.



## CREATION OF NEW VALUE CHAIN RELATIONS THROUGH NOVEL APPROACHES FACILITATING LONG-TERM INDUSTRIAL SYMBIOSIS

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### AIM

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CORALIS will create pathways for the decarbonization of resource and energy intensive sector value chains through the implementation of viable industrial symbiosis (IS) approaches combining new business and management strategies with innovative technology-based enablers. This approach will be demonstrated in three industrial areas covering different sectors, geographical dimensions and resources.

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**[WWW.CORALIS-H2020.EU](http://WWW.CORALIS-H2020.EU)**

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### CONCEPT

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IS has high potential for energy and resources savings. However, the IS knowledge base in Europe needs to be enhanced and supporting frameworks and data reporting structures harmonized to ensure data accuracy and comparability between IS initiatives. CORALIS will demonstrate the deployment of IS solutions and show how barriers faced by these initiatives can be overcome. CORALIS will address three factors (technical, managerial and economic) to define an IS readiness level: a useful indicator to establish the overall feasibility of an IS initiative. In addition, CORALIS will provide a harmonized framework for the monitoring of results and to evaluate impact from a life cycle perspective. This impact assessment methodology will be implemented in a virtual assessment platform to support the operation of partner industrial parks. The CORALIS approach will be demonstrated in three industrial parks, each of them supported by an IS facilitator, a neutral actor that will help guide the IS initiative and its exploitation. Three additional industrial parks will follow the project to implement IS initiatives after it has ended. A CORALIS Handbook will be published including recommendations on regulation and standardization as part of an ambitious dissemination and exploitation strategy.

### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958337.





A photograph of an industrial facility, possibly a refinery or chemical plant, with large storage tanks and distillation columns. In the foreground, there are green plants, possibly reeds or grasses, which are slightly out of focus. The sky is blue with white clouds. A large white circle with a red border is overlaid on the left side of the image, containing text.

"The Institute of Management – Scuola  
Superiore Sant'Anna as a member of  
CORALIS project has been putting effort to  
support the replication and exploitation of  
industrial symbiosis solutions developed  
for A.SPIRE sectors. It is a good chance to  
make a significant and concrete impact for  
sustainable industries."

**Scuola Superiore Sant'Anna  
Santa Anna School of Advance Studies**

# CHAPTER 8

CE-SPIRE-07-2020

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**ACCELWATER**

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**IWAYS**

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**AQUASPICE**

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**INTELWATT**

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**WASTE2FRESH**

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## ACCELERATING WATER CIRCULARITY IN FOOD AND BEVERAGE INDUSTRIAL AREAS AROUND EUROPE



### AIM

The main objective of the AccelWater project is to optimize freshwater consumption in the food and beverage industry under a water-waste-energy nexus by introducing beyond state-of-the-art water reclaiming, reusing and Artificial Intelligence-enabled monitoring and control technologies. This will enable the use of reclaimed water in the manufacturing processes of food and beverages will become possible.

[WWW.ACCELWATER.EU](http://WWW.ACCELWATER.EU)

### CONCEPT

The food and beverage industry is the EU's largest manufacturing sector, however it is one of the most water and energy intensive sectors worldwide and the companies involved in this sector typically produce a lot of waste. Specifically, this industry consumes 56% of the available water for industrial and urban use. In addition, food processing embeds 28% of the total energy used for production. Although progress has been made in increasing the water use efficiency through the use of modern technologies and methods, there is limited effort from the industry to minimize freshwater use during raw materials processing. In addition, high water consumption in industrial areas leads to increased production costs. Currently, solutions for wastewater treatment in industry include the use of clarification, membrane filtration, reverse osmosis, process water polishing, disinfection with water treatment chemicals and ultraviolet (UV) radiation, and biological treatment technologies. However, the use of these technologies under a water-waste-energy nexus is extremely limited.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958266.



## INNOVATIVE WATER RECOVERY SOLUTIONS THROUGH RECYCLING OF HEAT, MATERIALS AND WATER ACROSS MULTIPLE SECTORS

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### AIM

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The iWAYS project will develop a set of technologies and systems for industrial processes to recover water, heat and materials from exhaust streams, reducing resource consumption and increasing energy efficiency. The project's ambition is to contribute to a future where the industry is sustainable and emission-less, which will require the state of the art to be advanced in several fields. Each one of these innovations will generate impacts that will benefit not only European industry but society as well.

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[WWW.IWAYS.EU](http://WWW.IWAYS.EU)

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### CONCEPT

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iWAYS will create a new framework to streamline the condensation and collection of water from exhaust stream and purify the recovered water. Water within these streams, that is currently considered impossible or not cost-effective to recuperate, will be recovered by a new type of Heat Pipe Heat Exchanger and a water treatment system. At least 90% of the treated water will be recovered.

iWAYS solutions will produce a huge reduction in freshwater consumption and improve water efficiency - by up to 30% - with an extensive system analysis of the industrial production sites involved.

iWAYS operational changes will also recover heat. A substantial reduction in heat waste and energy consumption (from 10% to 80% heat recovery) will be introduced by recovering thermal energy and sensible heat.

The recovery of water, heat and materials, from exhaust streams, will represent a huge environmental benefit including reduction of 60% of final gaseous pollutants and more than 70% mass flow of gaseous emissions.

Three use cases will validate the iWAYS solutions in the ceramics, chemicals and steel tubes industries.

### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958274.



## ADVANCING SUSTAINABILITY OF PROCESS INDUSTRIES THROUGH DIGITAL AND CIRCULAR WATER USE INNOVATIONS



### AIM

AquaSPACE aims to promote circular water use in European Process Industries, fostering awareness of resource-efficiency and delivering compact solutions for industrial applications. This requires the industrial deployment of innovative water treatment and re-use technologies, closed-loop practices regarding water, energy and substances, a system for real-time monitoring, assessment and optimization of water (re-)use at different interconnected levels, and an effective organizational, regulatory and business framework.

[WWW.AQUASPACE.EU](http://WWW.AQUASPACE.EU)

### CONCEPT

AquaSPACE aims to advance efficient and circular water use in process industries through a genuinely holistic approach to boost water efficiency and circularity.

The project will operate across three domains: Industrial water use and re-use solutions (typology domain) focusing on the efficient implementation and management of closed water loop solutions, in combination with recovery of energy and other substances; Operational scope (time domain) to pursue water efficiency at all operational levels and time scopes; and Efficient water use and re-use technological innovations (technology domain) where AquaSPACE will build on previous work to propose and integrate technological components including: water saving and re-use best practices, an innovative smart Industrial Internet of Things sensory network combined with intelligent big data processing, and an analytics platform for real-time monitoring. An advanced simulation model of the production system and its value chain, with a special focus on water processes and use and an innovative water-aware Cyber-Physical System for production chain virtualization and monitoring will also be developed amongst other tasks.

### DISCLAIMER

The AquaSPACE project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No 958396.



## INTELLIGENT WATER TREATMENT TECHNOLOGIES FOR WATER PRESERVATION COMBINED WITH SIMULTANEOUS ENERGY PRODUCTION AND MATERIAL RECOVERY IN ENERGY INTENSIVE INDUSTRIES

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### AIM

intelWATT will develop innovative, cost-efficient, smart separation technologies for energy- and water-intensive industries. Three case studies in electricity production, mining and electroplating facilities will demonstrate water conservation along with energy production and material recovery. The solutions will also target zero liquid discharge while implementing maximum water reuse. Tailor made smart sensors and automated decision-making mechanisms will optimize the process conditions in real time. The case studies will include a demonstration prototype for Cooling Tower Blow Down water treatment, the sustainable production of energy and water using Reverse Electrodialysis and solar powered membrane distillation systems, and a novel, hybrid high recovery reverse osmosis / Ion exchange resin prototype to recover valuable electrolytes and conserve water in a plastic electroplating facility.

[WWW.INTELWATT.EU](http://WWW.INTELWATT.EU)

### CONCEPT

intelWATT's has identified key technologies for boosting water conservation in energy intensive processes and aims to improve the state of the art in these technologies to TRL7-8. The project is structured around three pillars:

1. Detailed characterization of the selected applications' water process streams and all basic process component requirements.
2. The customization of membranes, modules and resins at laboratory scale including the incorporation of smart monitoring. In parallel, module geometries, materials and configurations will be improved to reduce fouling and increase service life. The optimization of process parameters and materials will also be addressed.
3. The design, construction, commissioning and operation of the three demonstration prototypes including performance evaluation of the technologies in an operational environment and optimization of the process conditions.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958454.





## SMART INNOVATIVE SYSTEM FOR RECYCLING WASTEWATER AND CREATING CLOSED LOOPS IN TEXTILE MANUFACTURING INDUSTRIAL PROCESSES

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### AIM

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Have you ever imagined the actual impact of wastewater from factories?

Waste2Fresh is bringing exciting and groundbreaking innovative solutions specifically tailored to textile manufacturing processes to target the ever-growing sustainability concerns within the industry. Horizon 2020 project Waste2Fresh is addressing freshwater resource scarcity and industrial water pollution by bringing together leading textile manufacturing companies and relevant SMEs across Europe, as well as supporting Industry Innovation and Research and Technology Organisations.

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[WWW.WASTE2FRESH.EU](http://WWW.WASTE2FRESH.EU)

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### CONCEPT

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The Waste2Fresh system will integrate novel catalytic degradation approaches with highly selective separation and extraction techniques to deliver a closed loop system that assures near-zero discharge of wastewater, reduce current use of freshwater resources and increase the recovery of water, energy and other resources including organics, salts and heavy metals. The system will therefore increase resource and water efficiency and ultimately lead to considerable environmental gains helping to reduce EU and global environmental footprints.

This brand new, innovative technology to reduce wastewater and pollution, whilst also addressing the current unequal access to sustainable technology, will lead to greater prosperity and quality of life for all.

### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958491.



# CHAPTER 9

LC-SPIRE-08-2020

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**CEM-WAVE**

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**TOPAM**

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**HIPERMAT**

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**ACHIEF**

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**COMPASSCO2**

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**FORGE**

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## NOVEL CERAMIC MATRIX COMPOSITES PRODUCED WITH MICROWAVE ASSISTED CHEMICAL VAPOUR INFILTRATION PROCESS FOR ENERGY-INTENSIVE INDUSTRIES

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### AIM

CEM-WAVE aims to validate an innovative Microwave-assisted Chemical Vapour Infiltration technology to produce Ceramic Matrix Composites. Promising a significant reduction in production costs, CEM-WAVE answers the need for high-performance materials that can withstand the fluctuating and extreme manufacturing conditions created by the growing use of renewable energy sources in heavy industry.

[WWW.CEM-WAVE.EU](http://WWW.CEM-WAVE.EU)

### CONCEPT

The CEM-WAVE project strives to introduce Ceramic Matrix Composites (CMCs) in European industries through an innovative Microwave assisted Chemical Vapour Infiltration (MW-CVI) technology. With a significant reduction in production times and costs, MW-CVI makes the use of CMCs increasingly sustainable for a wide range of energy-intensive sectors with tangible benefits from both an environmental and a manufacturing standpoint.

In view of the need for transition from traditional to sustainable energy sources, CEM-WAVE will produce CMCs-based tubes and validate them inside radiant tube furnaces that are currently used in the steel industry. Given CMCs' higher service temperatures and longer lifetime, the project estimates that it can deliver an energy efficiency improvement of about 30% and extend the equipment's lifespan by 20%. Using state-of-the art Life Cycle Assessment methods, CEM-WAVE will demonstrate how transiting to this ground-breaking process could reduce CO2 emissions from radiant tube furnaces by at least 20%.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958170.



## TAILORING ODS MATERIALS PROCESSING ROUTES FOR ADDITIVE MANUFACTURING OF HIGH TEMPERATURE DEVICES FOR AGGRESSIVE ENVIRONMENTS

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### AIM

The aim of topAM is to develop novel oxide-particle-dispersoid strengthened (ODS) high-temperature alloys that are tailored for additive manufacturing (AM). The field of industrial application of such new materials are aggressive, high-temperature environments with challenging mechanical and corrosive operational demands.

[WWW.SPIRE2030.EU/TOPAM](http://WWW.SPIRE2030.EU/TOPAM)

### CONCEPT

The project targets topologically optimized and additively manufactured gas burner heads and heat exchangers. The use of such optimized devices under extreme service conditions is driven by the necessity for energy efficient solutions and extended lifetimes in future low-carbon technologies.

Combining the advantages of both, ODS alloys and AM, offers the potential to obtain unique material properties. To meet the project's objectives, the topAM consortium pools the following expertise:

- The use of advanced interlinked material simulation tools (integrated computational materials engineering - ICME) and artificial intelligence (AI) approaches for alloy, component, and process design.
- The application of a new processing route combining nanotechnologies for powder modification and AM by laser powder bed fusion (LPBF).
- The development and validation of a lifetime prediction model-based on thorough computational and experimental studies in corrosive, high-temperature environments.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958192.



## INNOVATIVE HIGH PERFORMANCE ALLOYS AND COATINGS FOR HIGHLY EFFICIENT INTENSIVE ENERGY PROCESSES



### AIM

The aim of ACHIEF is to deliver novel efficient materials and coatings-based solutions that are able to meet the extreme and fluctuating conditions currently employed in Energy Intensive Industries (EIIs) through the implementation of a novel Integrated Artificial Intelligence-aided Materials Toolbox (IAIMT).

[WWW.ACHIEF.EU](http://WWW.ACHIEF.EU)

### CONCEPT

From theoretical parameters and requirements, a novel IAIMT will propose innovative and adapted high performance materials and protective coatings. First, the virtually designed materials will be developed at small scale in laboratories. The project partners will define optimum process parameters for their specific requirements and will make a selection of the most efficient solutions among those proposed by the artificial intelligence toolbox.

ACHIEF aims to develop four types of new materials:

- Polymer derived ceramic (PDC) coatings with improved high temperature corrosion and erosion resistance.
- Advanced Chromium-steels grade with 15% improved creep resistance and higher temperature corrosion resistance.
- Innovative high temperature and creep resistance materials based on High Entropy Super Alloy (HESA) models
- High performance coatings based on High Entropy Alloy (HEA) nanocomposites.

After laboratory testing, the developed materials will be implemented in industrial environments to demonstrate their 'real world' performance and efficiency.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 858374.



## COMPONENTS' AND MATERIALS' PERFORMANCE FOR ADVANCED SOLAR SUPERCRITICAL CO<sub>2</sub> POWERPLANTS

### COMPAS<sub>s</sub>CO<sub>2</sub>

#### AIM

The aim of this project is to integrate solar energy into supercritical carbon dioxide (sCO<sub>2</sub>) Brayton power cycles. Concentrated solar radiation will be absorbed and stored in solid particles and the heat transferred to the sCO<sub>2</sub>. The participants will produce, test, model and validate novel particle and alloy combinations that meet the extreme operating conditions. A particle-sCO<sub>2</sub> heat exchanger will be validated in a relevant environment.

[WWW.COMPASSCO2.EU](http://WWW.COMPASSCO2.EU)

#### CONCEPT

In the envisaged solar-Brayton cycle, sCO<sub>2</sub> is used as the working media. The unique properties of sCO<sub>2</sub> (such as high density and low viscosity) will allow high efficiency for energy conversion to be achieved with a very compact design of the components compared to conventional Rankine steam cycles. The COMPAS<sub>s</sub>CO<sub>2</sub> project will focus on the connection between solar energy and sCO<sub>2</sub> Brayton cycles, enabling more efficient CO<sub>2</sub>-free electricity production. Novel concentrating solar power systems that use solid particles as the heat carrying and storing media will be considered. The project will research and develop particles for the solar cycle and alloys for the heat exchanger that can withstand the extreme operating conditions of temperature, pressure, abrasion, oxidation and corrosion experienced during the plant lifetime.

#### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958418.



## DEVELOPMENT OF NOVEL AND COST-EFFECTIVE COATINGS FOR HIGH-ENERGY PROCESSING APPLICATIONS



### FORGE

#### AIM

The equipment currently used in energy-intensive industries is vulnerable to corrosion and erosion as well as brittle fractures and cracking in the gas collection and kiln operations. Improvement of this equipment, and future equipment planned to be installed in these industries for the implementation of CO<sub>2</sub>-emission reduction technologies, is essential to increase production efficiency, component lifetime and reduce environmental impact. With this in mind, the FORGE project aims to provide the energy intensive industries with coatings solutions based on Compositionally Complex Materials and multiple Spraying Techniques.

**[WWW.FORGE-PROJECT.EU](http://WWW.FORGE-PROJECT.EU)**

#### CONCEPT

FORGE will explore a new materials space, starting from High Entropy Alloys and Ceramics. This will be achieved by combining machine learning models, thermodynamic calculations, and high-throughput experiments. The project will implement high-performance coatings with new compositionally complex alloys and ceramics on specific vulnerable process steps, such as CO<sub>2</sub> capture, waste heat recovery pipework, and components undergoing high wear and within kilns, to combat the degradation forces found in these environments. The project will also assure their effectiveness with the use of smart online monitoring of coating degradation. It is expected that, as an outcome of the FORGE project, overall capital and operating costs will be minimised especially in the specific sectors addressed in the project: the steelmaking, aluminium, ceramic tiles and cement industries.

#### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958457.



# CHAPTER 10

CE-SPIRE-09-2020

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**ReACTIV**

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## INDUSTRIAL RESIDUE ACTIVATION FOR SUSTAINABLE CEMENT PRODUCTION



### AIM

ReActiv will create a novel sustainable symbiotic value chain, linking by-products from alumina production to cement production. Bauxite Residue is the main by-product of the alumina sector produced at rates of 6.8 million tonnes per year in the EU, but the recycling rate is currently less than 200,000 tonnes per year. ReActiv will modify the bauxite residue properties, transforming it into reactive material suitable for production of new, low CO<sub>2</sub> footprint cement products.

[WWW.REACTIVPROJECT.EU](http://WWW.REACTIVPROJECT.EU)

### CONCEPT

To achieve its objectives the ReActiv project brings together the global leader in cement production with the biggest alumina producers along with top research and technology centres with significant expertise in the field. Furthermore, the European Alumina Association and the International Aluminium Institute are participating in the project to further the industrial dissemination and deployment of project results within the European and global alumina industry. The methodology developed under the ReActiv project can be replicated in by-products from other industrial sectors as well. To this end the project will seek to include, via modelling and/or lab-scale environment, other by-products in the developed flowsheets.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 958208.



# CHAPTER 11

DT-SPIRE-11-2020

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**AI-CUBE**

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## ARTIFICIAL INTELLIGENCE AND BIG DATA CSA FOR PROCESS INDUSTRY USERS, BUSINESS DEVELOPMENT AND EXPLOITATION



### AIM

The AI-CUBE project aims to enhance the understanding of digital technologies related to Artificial Intelligence and Big Data applied in process industries for eight SPIRE industrial sectors. AI-CUBE will define eight roadmaps, one for each SPIRE sector, highlighting practical recommendations on Artificial Intelligence (AI) and Big Data (BD) business cases that will serve as guidance for researchers, managers, and operators.

[WWW.AI-CUBE.EU](http://WWW.AI-CUBE.EU)

### CONCEPT

The AI-CUBE concept is based on a tri-axial mapping of AI and BD technologies, which will allow to map and visualize the status of the use of these technologies and their penetration in each SPIRE sector (cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, steel and water) and for each macro-application- process areas (e.g., R&I management and planning, process control, supply chain management, predictive maintenance, and product customization). The 'Cube Concept' allows to set the stage for the development and integration of four key sets of results:

- A novel AI and BD Maturity Level Assessment framework to support companies in evaluating the level of implementation of technologies.
- The CUBE, to be used as mapping tool by industries to assess their state of advancement in the penetration of digital technologies in the sector.
- A set of inspirational AI and BD Business Cases and an AI-CUBE Business Model Game.
- A set of eight sectoral roadmaps including easy to consult Infographics.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 958402.



# CHAPTER 12

LC-SC3-EE-6-2018-2019-2020

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**R-ACES**

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**INCUBIS**

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## FRAMEWORK FOR ACTUAL COOPERATION ON ENERGY ON SITES AND PARKS



### AIM

The vision of R-ACES is to support high-potential industrial parks and clusters to become ecoregions that reduce their CO2 emissions by at least 10%. R-ACES will create ecoregions where multiple stakeholders engage in energy cooperation by exchanging heat/cold streams, investing in renewable energy solutions, and/or managing energy streams with the use of the R-ACES toolbox.

[WWW.R-ACES.EU](http://WWW.R-ACES.EU)

### CONCEPT

R-ACES project is built around six impact-oriented assumptions:

- Maximizing impact by focusing on high-priority, high-impact regions as preselected through available roadmaps.
- Providing practical easy-to-use tools to practitioners to help them to assess their local situation in the various phases of energy cooperation.
- Including monitoring of sustainability impact and commitment level in assessment tools and in peer-to-peer events.
- Attracting regions and professionals via peer-to-peer contact in dedicated events, in relevant storytelling and use cases.
- Being effective by making a clear choice to promote innovative technologies and smart energy monitoring tools.
- Ensuring impact beyond the project time by building networks, cooperating with existing organizations and effective transfer of project results.

With the R-ACES approach the main phases of the project are fully supported. First there is the initiation and development of three pilot schemes. This initial phase will be followed by an expansion with the involvement of ten ecoregions, scaling-up and widescale communication of project results.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 892429.



## AN INDUSTRIAL SYMBIOSIS INCUBATOR FOR MAXIMIZING WASTE HEAT/COLD EFFICIENCY IN INDUSTRIAL PARKS AND DISTRICTS

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### AIM

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INCUBIS aims to maximize the utilization of industrial waste heat/cold by unlocking the market potential of Energy Symbiosis in Europe. This will be achieved by deploying a consultancy service specialized in incubating Energy Symbiosis Project Developers (i.e., Facilitators) by supporting them throughout project development and by building their capacity to overcome non-technical barriers.

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**WWW.INCUB-IS.EU**

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### CONCEPT

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Energy Symbiosis (ES) is the commercial exploitation of excess heat/cold produced by industrial activities to be used as a source of energy for other industrial and/or urban activities. It has a number of proven benefits. These include: reduction of energy costs and CO<sub>2</sub> emissions; increased revenues, jobs and local investments; decreased reliance on non-renewable resources and imports.


Many successful ES projects have been developed by intermediary organizations (Facilitators) that act as knowledge brokers and project developers. INCUBIS will deploy a Virtual Incubator of ES Facilitators delivering a set of tools, methods, best practices, training resources and mentoring services to organizations that are ideal candidates for systematically facilitating ES projects. INCUBIS will be initially deployed in five demonstration regions, each one with different characteristics and challenges, but gradually expand its reach throughout Europe.

### DISCLAIMER

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 894800.





“After 24 months, the INCITE project is making good progress in the design & engineering of its two demonstration plants. The construction begins in 2022 in Belgium and Italy. INCITE aims at widening the industrial implementation of chemo-enzymatic processes that are flexible, productive, safe and environmentally friendly. “



# CHAPTER 13

LC-SC3-NZE-5-2019-2020

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**LEILAC2**

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**C4U**

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## LOW EMISSIONS INTENSITY LIME AND CEMENT 2: DEMONSTRATION SCALE



### AIM

The majority of the CO<sub>2</sub> emissions from the production of cement are released directly and unavoidably from the processing of the raw materials. The LEILAC projects are developing a breakthrough technology that aims to enable the cement and lime industries to capture these unavoidable CO<sub>2</sub> emissions emitted from the raw limestone at low cost, quickly and efficiently.

[WWW.PROJECT-LEILAC.EU](http://WWW.PROJECT-LEILAC.EU)

### CONCEPT

The Calix process changes the existing process flows of a traditional calciner by indirectly heating the limestone via a special reactor. This unique system enables pure CO<sub>2</sub> to be separated and captured as it is released from the limestone. LEILAC operates, in principle, with the same specific energy as conventional plant. Unlike other carbon capture technologies, the new process does not involve any additional processes or chemicals.

The first LEILAC project sought to apply this technology to the cement sector. This successor project, LEILAC2, which started in 2020, is applying the technology at a larger scale and will address the major remaining hurdles. In LEILAC2 the process will be capable of capturing 20% of the plant's capacity, or around 100,000 tonnes of CO<sub>2</sub> per year – equivalent to the combined annual emissions of 55,000 cars.

The technology will also be electrified and can use hydrogen and there is the possibility to provide flexible load balancing, thereby enabling power grids to use more renewable energy.

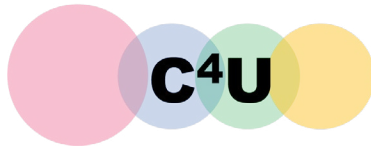
The LEILAC2 Demonstration plant is a module that can be easily duplicated, paving the way for swift, cost effective deployment of this carbon capture technology across the globe.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 884170.



## ADVANCED CARBON CAPTURE FOR STEEL INDUSTRIES INTEGRATED IN CCUS CLUSTERS



### AIM

The C4U project aims to achieve four headline research objectives. The project will elevate two CO<sub>2</sub> capture technologies, known as DISPLACE (High-temperature sorption-displacement process for CO<sub>2</sub> recovery) and CASOH (Calcium Assisted Steel mill Off-gas Hydrogen production), from TRL5 to TRL7 and design for their optimal integration in the steel industry. It will analyse the economic, environmental and business impacts and opportunities of applying CCUS (Carbon capture, utilization, and storage) in a large-scale (TRL9) steel plant in a North Sea Port industrial cluster and develop and test approaches with stakeholders and end-users to assess and advance societal readiness for CCUS in industrial clusters. Finally, the project will ensure that its results are exploited to their full extent and disseminated to relevant stakeholders to facilitate the large-scale rollout of CCUS.

[WWW.C4U-PROJECT.EU](http://WWW.C4U-PROJECT.EU)

### CONCEPT

Funded by the European Union's Horizon 2020 programme, C4U is a holistic interdisciplinary project addressing all the essential elements required for the optimal integration of CO<sub>2</sub> capture in the iron and steel industry as part of the CCUS chain. This spans demonstration of two highly efficient solid based CO<sub>2</sub> capture technologies for optimal integration into an iron and steel plant and detailed consideration of the safety, environmental, societal, policy and business aspects for successful incorporation into the North Sea Port CCUS industrial cluster in Belgium and the Netherlands.

### DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 884418.





## PROJECTS ENDED IN 2020

	PROJECT ACRONYM	PROJECT TITLE
CIRC-01-2016-2017	<b>CIRC-PACK</b>	Towards circular economy in the plastic packaging value chain
EE-17-2016-2017	<b>DryFiciency</b>	Waste Heat Recovery in Industrial Drying Processes
	<b>Smartrec</b>	Developing a standard modularised solution for flexible and adaptive integration of heat recovery and thermal storage capable of recovery and management of waste heat
EE-18-2015	<b>Indus3Es</b>	Industrial Energy and Environment Efficiency
	<b>I-ThERM</b>	Industrial Thermal Energy Recovery Conversion and Management
LCE-25-2016	<b>FReSMe</b>	From residual steel gasses to methanol
SPIRE-01-2016	<b>INSPIREWater</b>	Innovative Solutions in the Process Industry for next generation Resource Efficient Water management
	<b>SPOTVIEW</b>	Sustainable Processes and Optimized Technologies for Industrially Efficient Water Usage
SPIRE-02-2016	<b>COCOP</b>	Coordinating Optimisation of Complex Industrial Processes
	<b>CoPro</b>	Improved energy and resource efficiency by better coordination of production in the process industries

	PROJECT ACRONYM	PROJECT TITLE
SPIRE-02-2016	<b>FUDIPO</b>	Future Directions of Production Planning and Optimized Energy- and Process Industries
SPIRE-03-2016	<b>REHAP</b>	Systemic approach to Reduce Energy demand and CO2 emissions of processes that transform agroforestry waste into High Added value Products
SPIRE-04-2016	<b>IMPROOF</b>	Integrated model guided process optimization of steam cracking furnaces
SPIRE-05-2015	<b>MEMERE</b>	MEthane activation via integrated MEmbrane REactors
SPIRE-07-2017	<b>SUPREME</b>	Sustainable and flexible powder metallurgy processes optimization by a holistic reduction of raw material resources and energy consumption
SPIRE-08-2017	<b>Carbon4PUR</b>	Turning industrial waste gases (mixed CO/CO2 streams) into intermediates for polyurethane plastics for rigid foams/building insulation and coatings
SPIRE-09-2017	<b>PORTABLECRAC</b>	Portable solution for the electrochemical regeneration of activated carbon
SPIRE-10-2017	<b>CO2EXIDE</b>	CO2-based Electrosynthesis of ethylene oXIDE
SPIRE-13-2017	<b>SCALER</b>	Scaling European Resources with Industrial Symbiosis
WASTE-1-2014	<b>FISSAC</b>	Fostering industrial symbiosis for a sustainable resource intensive industry across the extended construction value chain

