



SPIRE 2050 Vision

***Towards the
Next Generation of
European Process
Industries***

Working document



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the A.SPIRE Team**

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SPIRE:

Setting the benchmark for cross-sector collaboration in research and innovation

Since its launch in late 2013, SPIRE, the European contractual public-private partnership (cPPP) involving the cement, ceramics, chemicals, engineering, minerals, non-ferrous metals, steel and water sectors under the Horizon 2020 programme, has been successfully developing breakthrough and key enabling technologies and sharing best practices along all stages of existing value chains to enable a competitive, energy and resource efficient process industry in Europe.

Founded with the express purpose of encouraging cross-sectorial cooperation, SPIRE has exceeded its own high expectations in delivering an unprecedented level of cooperation and knowledge transfer between industry sectors, setting a challenging benchmark for others to emulate.

TOWARDS THE NEXT GENERATION OF EUROPEAN PROCESS INDUSTRIES

Enhancing our cross-sectorial approach in research & innovation

Dear SPIRE stakeholders,

I am delighted to introduce SPIRE's new Vision 2050: **'Towards the next generation of European Process Industries - Enhancing our cross-sectorial approach in research and innovation'**. This vision foresees an integrated and digital European Process Industry, delivering new technologies and business models that address climate change and enable a fully circular society in Europe with enhanced competitiveness and impact for jobs and growth.

Our SPIRE community, which embraces both industries (including SMEs) and research and technology organisations in Europe has initiated 77 innovative projects with a total estimated private investment of €3 bn (representing an estimated leverage factor of 7), and developed 221 new systems and technologies. SPIRE **SMEs have reported an average increase of almost nine new employees** (created or being created) since their involvement with the cPPP, which is well over the average of two employees per enterprise in the EU 28. SPIRE SMEs have also seen their turnover increase by an estimated 25% - double the EU average.

The European Process Industry itself contributes to the EU Jobs and Growth agenda with 6.3 million jobs directly created and a further 19 million indirectly created in Europe. We are committed to deliver a higher added-value for our planet and society.

SPIRE has set the benchmark for multi-sector collaboration and the sectors have jointly defined this new Vision for the next generation of European Process Industries. Now is the time for maximum cooperation. SPIRE's sectors share this vision that further integration and collaboration will facilitate the achievement of the transformational innovations required. This is needed to make the step change to world-leading sustainability and competitiveness for better jobs and wealth in Europe.

SPIRE also has the ambition to broaden its future cooperation by directly working with EU Member States, contributing fully to the development of sustainable and smart regions, as well as ensuring that the benefits of our work are deployed for the benefit of all EU citizens.

I look forward to working with you all personally and to achieving our Vision 2050.

Yours sincerely,



Daniel Gauthier

Chairperson of the Board, A.SPIRE aisbl





CONTENT

| | |
|--|----|
| 1. In challenges, SPIRE sees opportunities | 1 |
| 2. Our vision towards 2050 | 3 |
| 3. The technology drivers | 7 |
| 4. Our impacts and ambitions | 17 |
| 5. Further case examples of R&I under SPIRE 2050 | 25 |
| 6. SPIRE in the EU innovation landscape | 27 |

1. IN CHALLENGES, SPIRE SEES OPPORTUNITIES

Time to boost transitions

The extent and the pace of the transitions that our society requires over the next decades are pushing the limits of human knowledge and our ability to deploy innovations.

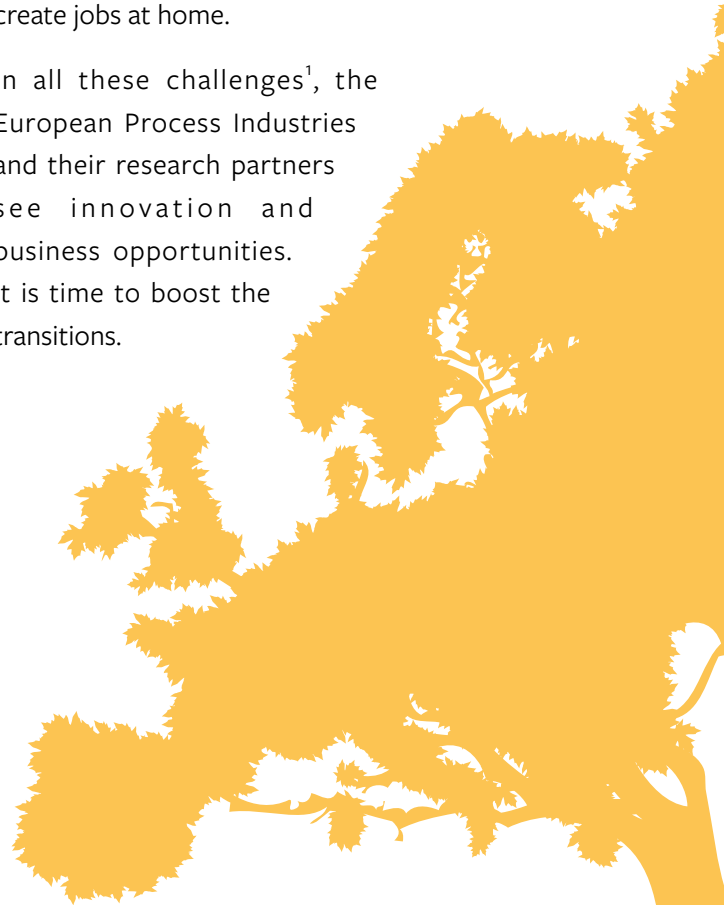
Climate change is one of the preeminent issues of our time. The world is still far from being on track towards the objectives of the Paris Agreement. The **need to transition to a carbon-neutral economy** is more pressing than ever. Citizens, cities, regions, Member States and the EU are deploying a sophisticated mosaic of policies, measures and actions to transform the way we move, our built environment, the energy mix we use and our consumption patterns.

In a context of resource scarcity and urbanisation, our societies also need to **transition quickly towards circular business models and practices**, aiming to maintain the value of products, materials and resources in the economy for as long as possible, and at minimising the generation of waste. In this matter also, an enabling regulatory framework must be progressively put in place at the appropriate political levels.

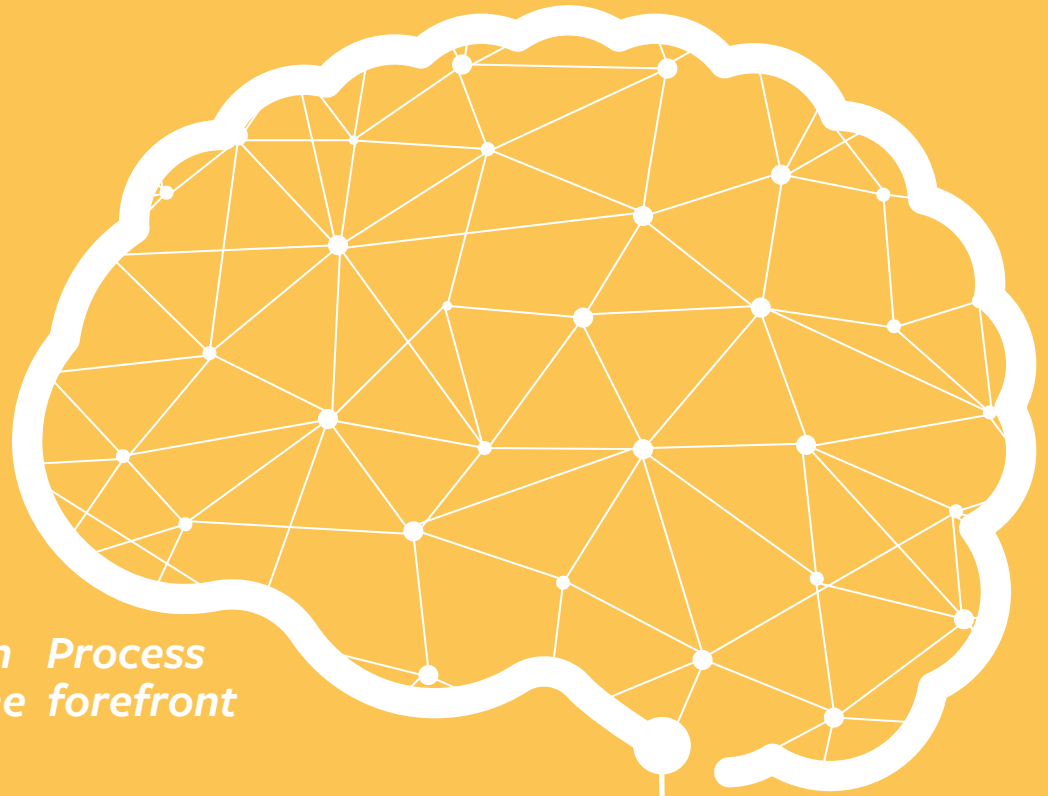
On the market demand side, **citizens are increasingly requiring customised products, services and solutions**. They pay growing attention to health, environmental impacts,

responsible sourcing and controlled quality when making consumption decisions. A growing social demand for shorter value chains, local production and local value creation is also being observed. Balancing the framework for global competitiveness of our industries is therefore essential to keep and create jobs at home.

In all these challenges¹, the European Process Industries and their research partners see innovation and business opportunities. It is time to boost the transitions.



¹ Other crucial challenges for European citizens – such as their legitimate concerns for a safe working and living environment – are not being disregarded by the European Process Industries, on the contrary: they are being addressed by each individual company and/or sectors' associations.



The European Process Industry at the forefront of innovation

The European Process Industry sectors are collectively at the forefront in boosting these transitions.

Europe and its Process Industries will only succeed if they jointly define and implement ambitious research, innovation, industrial and financing policies enabling fast and smooth transitions. Enhancing competitiveness, to maintain - or restore – the value-adding and job-creating activities of the many value chains established in Europe:

- > Achieving the objectives of the Paris Agreement, to limit average global temperature increases to well-below 2 degrees.
- > Closing the loops within and across value chains, to achieve a fully circular economic model.
- > Providing innovative products, services and jobs, to enhance the welfare of our citizens.

These challenges will not be solved by business-as-usual solutions and incremental improvements. **A disruptive transformation is needed within the next few decades** supported by breakthrough and key enabling technologies. Advanced manufacturing and **processing** technologies will make the difference. **The future of SPIRE sectors is closer cooperation and synergies.** It will no longer focus separately on individual sectors and locations but on an “ever-closer union” of the EU process industries.

Process industries are the industries of tomorrow. They have collectively endorsed the objectives of the Paris Agreement and **they are key enablers for a “well-below 2 degrees” future scenario for our planet:** materials and solutions for wind turbines, solar plants, high-speed trains, road infrastructure, energy-efficient cities and regions will be designed, manufactured and supplied by SPIRE industries. **They are also the “Hubs For Circularity” for energy and resources within and across value chains.**

2. OUR VISION TOWARDS 2050

SPIRE: the transformations we want to see by 2050

1. CONNECTING THE DOTS

A smart integration of process industries across Europe

Our Vision is that the future of Europe lies in a strongly enhanced cooperation across industries – including SMEs – and across borders, enabling a real step change in competitiveness and sustainability performance.

Facilities will increasingly become physically and digitally interconnected.

Innovative “industrial ecology” business models will be developed to foster the redesign of the European industrial network: SPIRE aims to build bridges across sectors and between countries.

The benefits from artificial intelligence, cyber physical and blockchain technologies will also be maximised across sectors, boosting process efficiency, generating new business models and making sure that European value chains and related data remain in Europe.

SPIRE 2050 VALUE PROPOSITION

An integrated and digital European Process Industry, fostering a “well-below 2°C” scenario and a fully circular future for our planet and society.

2. BRIDGING THE CLIMATE TECHNOLOGY GAP

Process industries as enablers for a carbon-neutral economy

The Process Industries will fully contribute to the transition of the global economy towards a “well-below 2 degrees” scenario. They will develop and scale up the transformative technologies and solutions we need for a carbon-neutral economy. The demonstration and application of these technologies in the Process Industries will become a cornerstone for circularity and the avoidance of greenhouse gas emissions.

3. CREATING HUBS FOR CIRCULARITY

Process industries, regions and cities deploying circular economy at scale

The European Process Industries will join forces with regions and cities to establish “Hubs For Circularity” for energy and resources in Europe. The Process Industries are indeed crucial to deploy a circular economy at scale: they are by nature resource and energy-intensive, which gives them a unique potential to boost recycling, re-use and recovery rates and to close the loops across sectors and within smart regions and cities.

The required efforts to achieve this Vision remain huge. The required technologies are either not currently economically feasible or simply do not exist. SPIRE is crucial to bridge this gap through impactful Research and Innovation initiatives. It will mobilise its entire innovation ecosystem (industries, SMEs, academia and research organisations), and engage with political authorities and civil society.



Particularly... what will the future look like?

Resources, energy and waste flows across sectors and political borders will be multiplied and scaled up. Innovative “industrial ecology” models will bring energy production (including renewables) and industrial facilities much closer to each other and help achieve a full recovery of waste heat, a full deployment of urban mining opportunities (including from old deposits) and a complete ban of waste landfilling. Renewable energy generation and industrial processes will be physically and digitally interlinked.

The electrification of processes, the use of hydrogen as an energy vector and the use of renewables will be deployed at scale and cut down greenhouse gas emissions. Residual carbon emissions will be collected and wherever possible recirculated as resources for other industrial processes or - ultimately - sustainably stored. New value-adding activities will be created, requiring new highly skilled job profiles and enhancing the welfare of our countries, regions and cities.



SPIRE: positive contributions to business, planet and society

SPIRE will develop newly required technologies and systems, targeting their implementation in the most energy-efficient, resource-efficient and cost-efficient way to the benefit of the Process Industry sectors and society overall.

The cross-sectorial nature of SPIRE represents a unique asset to jointly address transversal innovation challenges. It also offers the opportunity to build on sector-specific technologies and approaches, to tailor them to other process industry sectors and to maximise their positive impact on interconnected industries.

This targeted transformation will enhance the competitiveness of entire EU value chains delivering

growth and jobs in Europe. It will make Europe the global leader in innovative solutions for a more sustainable and prosperous society. An enabling and predictable regulatory and financing framework should also be in place: it is essential to make sure that talent is attracted so that Europe secures a highly qualified and skilled workforce and investments are made in European territory, translating innovation into tangible welfare and benefits for European citizens.

SPIRE strives for positive change at local, regional, Member State and European levels, delivering a positive triple bottom-line value creation **- for business, planet and society.**

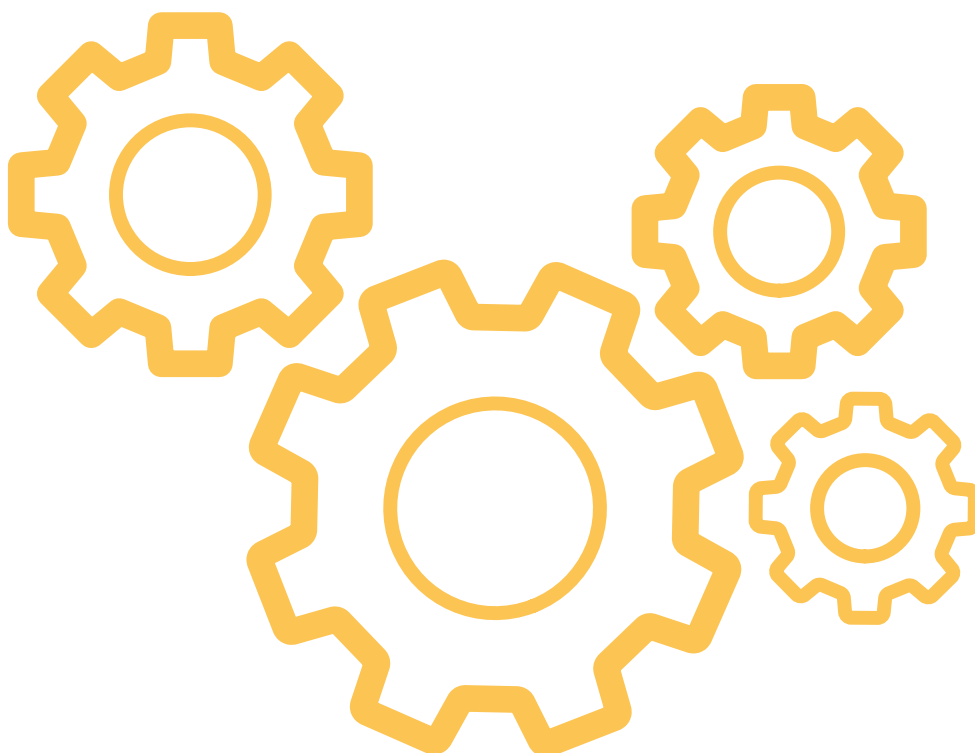


3. THE TECHNOLOGY DRIVERS

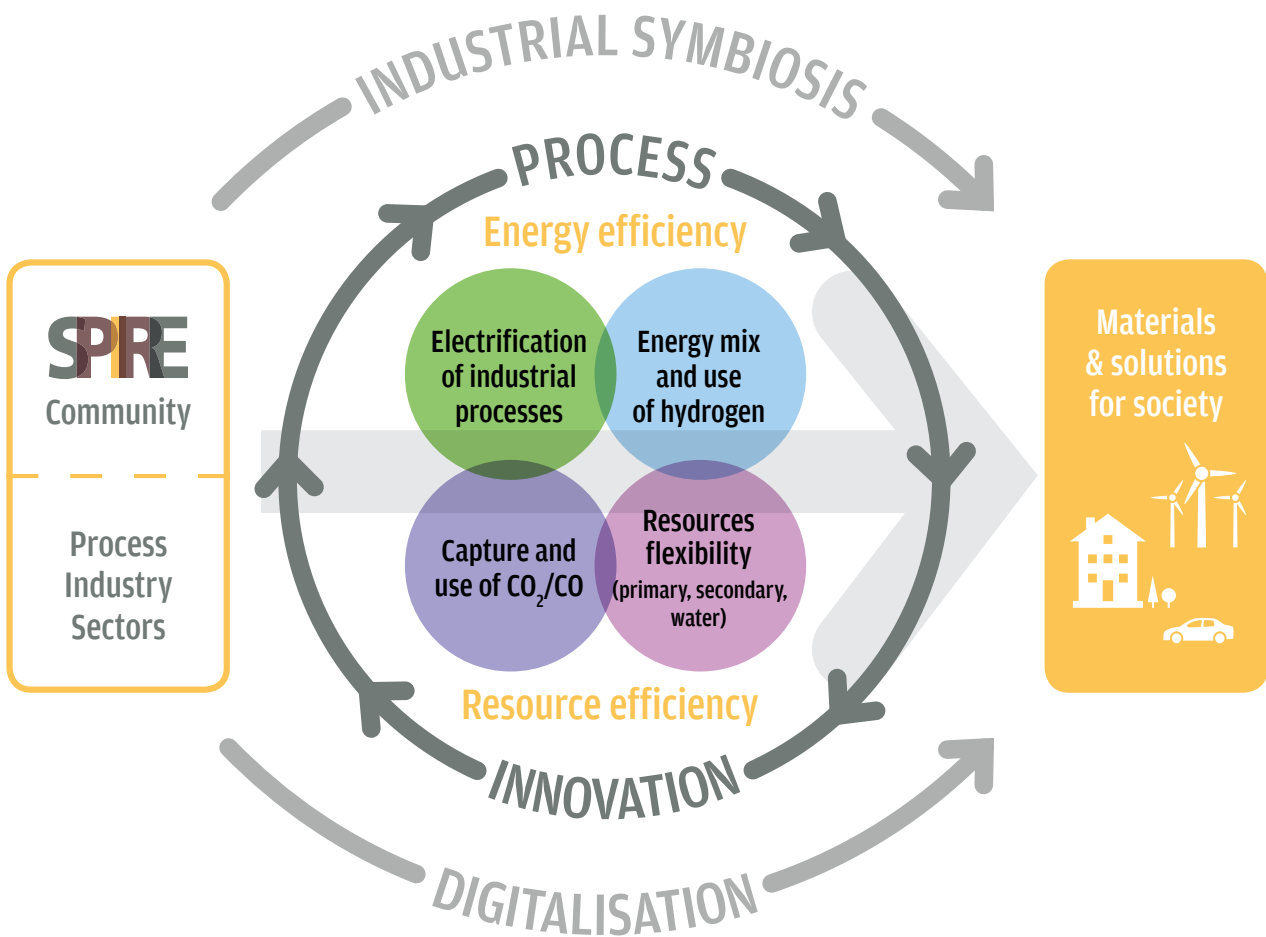
The European Process Industries are essentially providing materials and solutions to mature and new markets. Very few greenfield production facilities are consequently being built in Europe. Significant retrofitting, and revamping investments that lead to new industrial plants in Europe, are the main levers to deliver the changes we want to see.

Resource and Energy Efficiency are the core focus areas, fostering a “well-below 2 degrees” scenario and fully circular future for our planet and society. They are highly interconnected².

Four “technology drivers” will help the Process Industries achieve their SPIRE ambitions. Two transversal topics – industrial symbiosis and digitalisation – will support and accelerate the transformations.



² An improvement in primary resource efficiency will generally lead to a better energy efficiency performance. The correlation can however sometimes be reversed – which then requires building intelligence to enable informed decisions to select the most sustainable option.

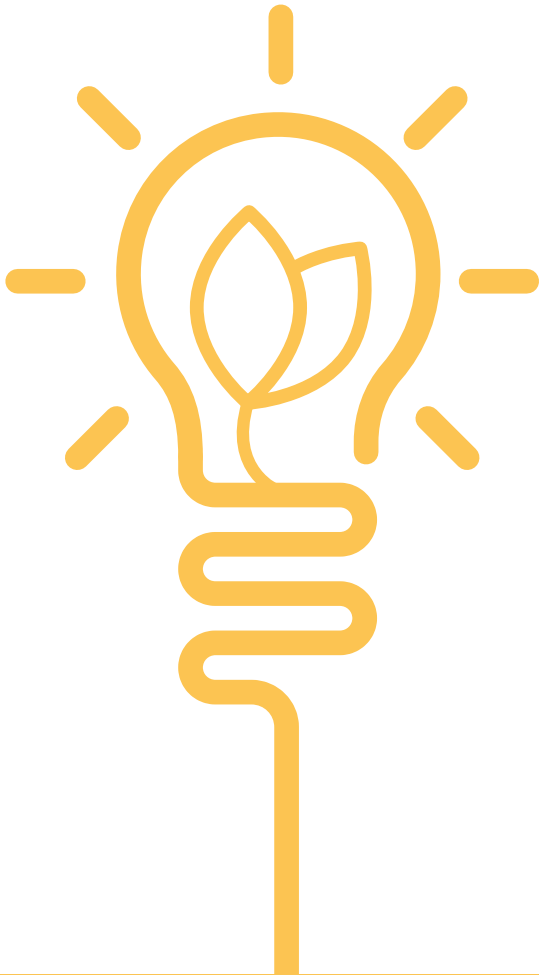


SPIRE 2050 VISION

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

The SPIRE technology drivers

The following technologies will drive the change portrayed in our SPIRE 2050 Vision, for our industry and our society:



ELECTRIFICATION OF INDUSTRIAL PROCESSES

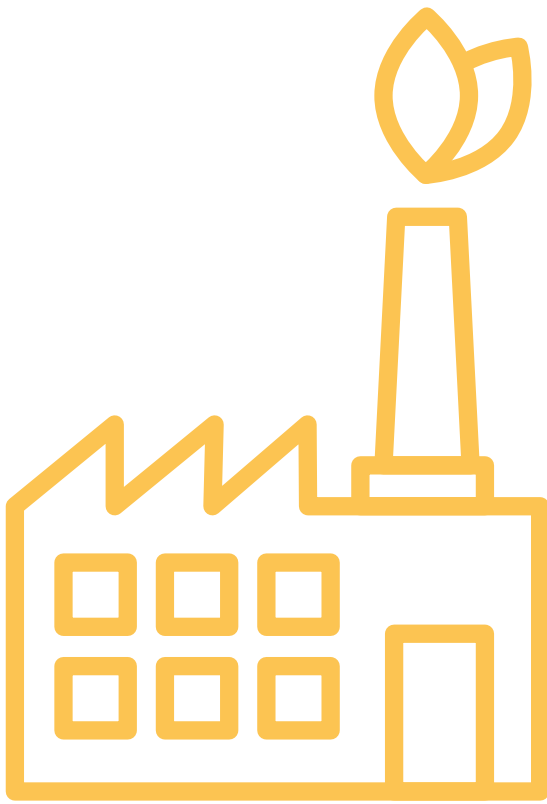
Electrification of industrial processes, as a pathway towards carbon neutrality: adaptation of industrial processes to the switch towards renewable electricity (e.g. electrochemistry, electric furnaces or kilns, plasma or microwave technologies).

Process industries also offer the opportunity to help balance supply and demand on the electricity grid, which will become even more crucial than today with the relative increase of the volatile renewable energy sources. New ICT tools will be needed to help process industries leverage their energy efficiency and flexibility in sophisticated electricity markets while integrating technical, economic and commercial constraints. Clusters of industrial facilities – interconnected across sectors and borders – will significantly enhance the reliability and stability of the European grid.

CASE EXAMPLE

Electrification of industrial processes

In the chemical industry, the direct use of electricity can be considered for heat/steam/vapour generation or upgrade. Direct use can be achieved through developing and deploying efficient technologies for electrochemistry and use of unconventional energy sources (e.g. microwaves, ultrasound, plasma). In the steel industry, primary iron production through a flexible electro-winning process based on iron ore must be further explored. All electrification projects would require the integration of process industries into a renewable-intensive grid, which would drastically reduce CO₂ emissions from the respective processes.



ENERGY MIX

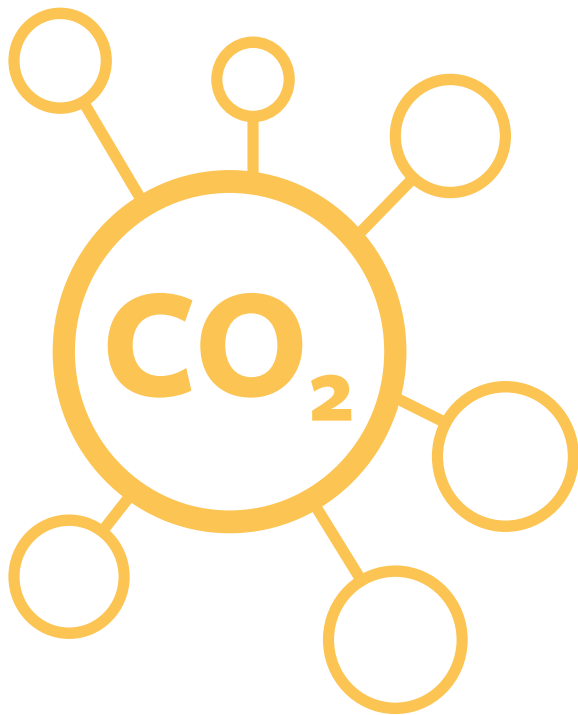
Energy mix, and use of hydrogen as an energy carrier and feedstock:

- > production, transport, intermediate storage and feeding of renewable electricity, low-carbon fuels, bio-based fuels, waste-derived fuels, development of robust processes able to use mixed energy sources, minimisation of waste heat and methods to address fluctuation of supply,
- > supply of competitively priced renewable energy, production, transport, feeding and processing of low-carbon and affordable hydrogen.

CASE EXAMPLE

By-products and recycled materials as feedstock for mineral industries

Moving beyond recycling of own waste and by-products, the ceramic industry offers the potential to replace at least 85% of natural raw materials with various properly balanced waste types to achieve lower firing temperatures compared to traditional feedstocks. This could result in a 15-20% energy consumption reduction during the milling stage and at least 5-10% of CO₂ emissions. The cement industry also offers massive potential to further increase its use of alternative raw materials both in clinker kilns and cement mills. The latter could result in a decrease of ~4% in CO₂eq emissions by 2050. Alternative magnesia sources are also to be explored for the refractory industry.



CAPTURE AND USE OF CO₂ FROM INDUSTRIAL EXHAUST GASES

Capture and use of CO₂ from industrial exhaust gases (including all technologies aiming at “absorbing” greenhouse gases in order to avoid emissions and to achieve overall carbon neutrality): capture, collection, intermediate storage, pre-treatment, feeding and processing technologies, intelligent carbon management, aiming at fuels or chemicals production or at mineralisation in (building) materials (“non-geological” long term and permanent storage³).

CASE EXAMPLE

CO₂ from steel, cement and mineral industries as feedstock for chemicals and alternative fuels

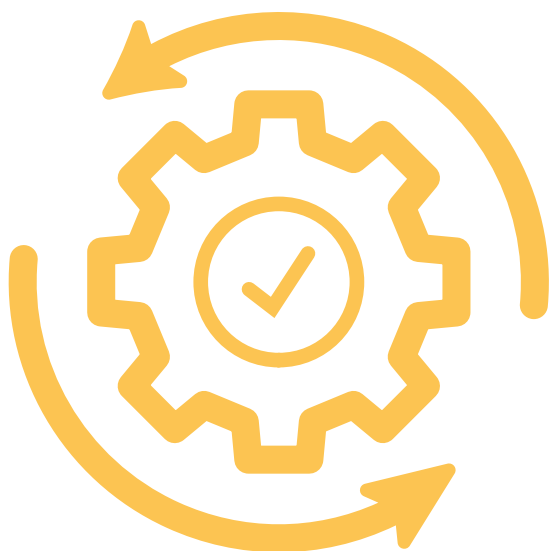
Technological developments are required to deploy carbon capture and use into basic chemicals, polymers, speciality chemicals and fuels in order to secure cost competitive access to CO₂ / CO from industrial sources, efficient conversion processes and a cost-efficient production of low-carbon hydrogen. A range of technologies are to be explored and scaled up. If 50% of the production of methanol and olefins was achieved from CO₂ / low carbon H₂, this could lead in 2050 to 30.3 million tonnes of avoided CO₂ emission (ambitious deployment scenario, DECHEMA study, 2017).

³ The Process Industries acknowledge the potential future contribution of geological storage of CO₂ to achieve the European carbon neutrality objective within agreed deadlines. Technology development and innovation remain required for the capture and use of CO₂. Geological storage raises other open questions related to infrastructure (pipelines and injection), appropriate injection sites (geological research) as well as social acceptance, which are not in the scope of action of SPIRE.

RESOURCE EFFICIENCY AND FLEXIBILITY

Resource efficiency and flexibility: all technologies and systems aiming at:

- > maximising efficiency in the use of primary resources, ensuring higher yields from complex and fluctuating raw material feeds,
- > the full re-use, recycling or recovery of waste as alternative resources: collection, sorting, transportation, pre-treatment and feeding technologies; all possible resource streams to be considered and explored (notably plastic waste, metallurgical slags, non-ferrous metals, construction and demolition waste, etc.) – aiming at achieving an optimised symbiotic industrial network⁴,
- > zero water discharge, maximal recovery of sensible heat from waste water, new technologies and systems supporting the substitution of chemical solvents by water (e.g. in biobased processes) including new water treatment and symbiosis concepts,
- > the full traceability of value chains, as a crucial instrument to deploy circular business models at scale and to serve society's and customers' growing demand for product-related information.



CASE EXAMPLE

Chemical conversion of plastic waste

Chemical recycling (conversion) of plastic waste into valuable materials or fuels is a crucial route for further circularity of the value chain. Chemical conversion technologies rely mainly on the processes of depolymerisation through chemo or bio-catalysis, pyrolysis (hydro thermal cracking or fluid catalysed cracking) and gasification. Today only 8% of plastic wastes are recycled. The focus should notably be on enhancing economic competitiveness of commercial-scale technologies to deliver on the EU ambition to achieve 100% reusable or recyclable plastic packaging by 2030.

⁴ The overall life-cycle impact of materials (notably in terms of greenhouse gas emissions) will be considered to guide decision-making.

The SPIRE transversal topics

The following two “transversal topics” will help support and accelerate the transformation:

INDUSTRIAL SYMBIOSIS

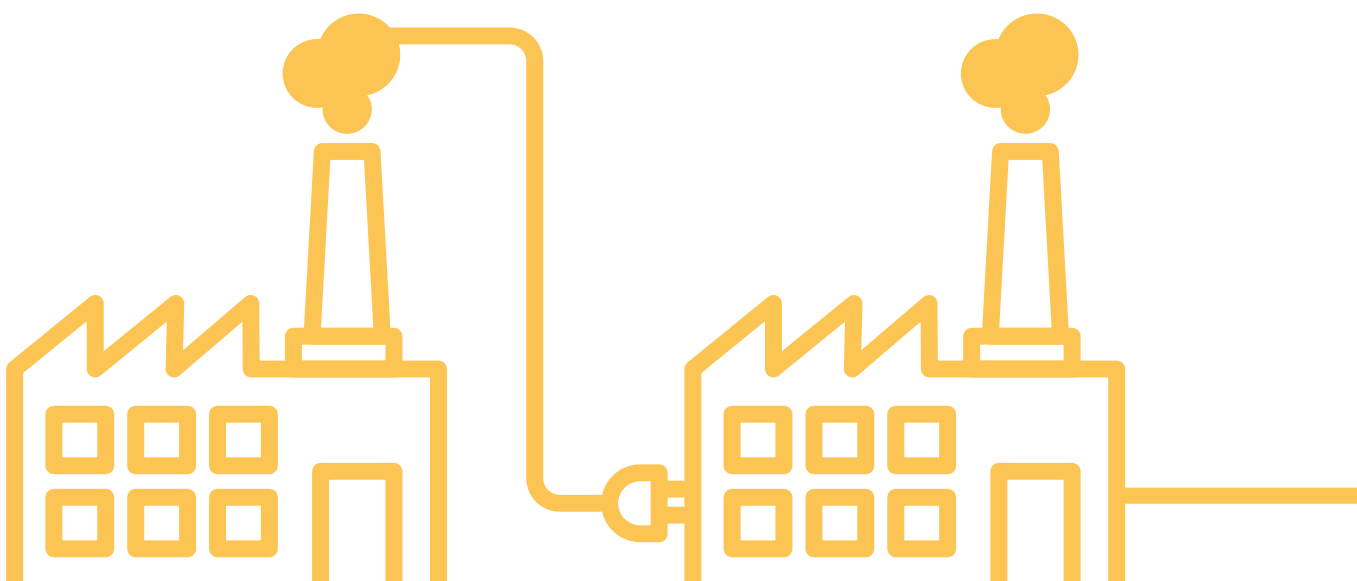
An intense collaboration across energy intensive sectors, their customers and suppliers (many of them being SMEs) is crucial to deliver a real step change: a circular European economy can only be achieved through exploration and deployment of industrial symbiosis opportunities, creating synergies beyond sectoral and political boundaries⁵.

These synergies will enable operators to react as flexibly as possible to fluctuations in the supply of raw materials and in other conditions (e.g. availability of green energy, energy prices, etc.). Process technologies will consequently require adaptation. An enhanced coordination of production within and across companies will be achieved.

SPIRE is cross-sectorial. This makes it the most appropriate vehicle to explore and pilot these symbiosis opportunities.

Under Horizon2020, SPIRE has shown its strength in developing Industrial Symbiosis technologies. For Horizon Europe, we aim to bring Industrial Symbiosis technologies to the next level across sectors and across borders.

SPIRE aims at going a step further. By strengthening collaboration with EU Member States, regions and cities, **Industrial-Urban Symbiosis models** can be established and deliver a positive impact at the most relevant level within regions and urban areas.



⁵ This can also apply beyond process industries. Major opportunities are notably to be unlocked through strong partnerships between process industries, the electricity sector and European regions.



DIGITALISATION

Digitalisation of process industries has a tremendous potential to dramatically accelerate change in resource management, process control and in the design and the deployment of disruptive new business models.

In the field of process control, digital technologies (through data collection, data storage and extraction of new information for use within and across companies) help provide detailed insights into resource availability (energy, water, primary and secondary resources etc.), use and quality, up to the level of each individual user. They will further contribute to optimise production yield, enhance resource flexibility and accelerate synergies

between sectors and with energy suppliers, through the development of platforms, databases, and advanced near real-time decision support systems.

A cross-sectorial approach offers unique opportunities to properly address legitimate and common concerns regarding cyber security.

Ultimately, it is essential that data from process industry and related value chains remain in European hands and this aspect should be included in SPIRE calls under Horizon Europe.

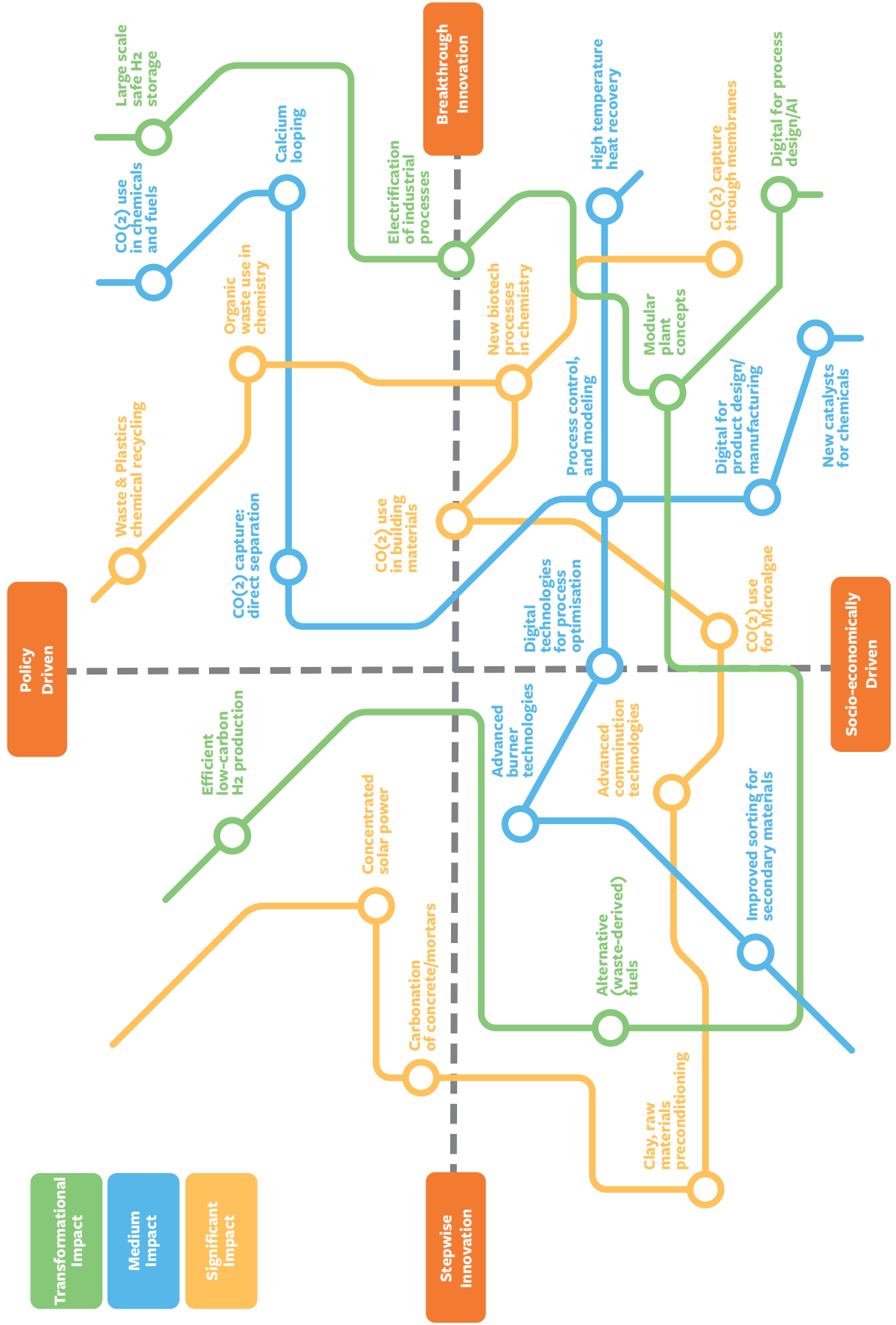
The levels of impact of innovative technologies

For illustration purposes, 26 technological innovation trends for the Process Industries have already been identified⁶ and mapped according to their probable impact, their “stepwise” (or incremental) versus “breakthrough” nature and the underlying drivers behind each trend. These and other technologies to be defined at roadmap level will be developed by new SPIRE projects under Horizon Europe.

This combination of stepwise and breakthrough innovations with different levels of impact, at policy or socio-economic levels, will help us deliver the necessary transformations to achieve our ambitious SPIRE 2050 Vision. Public policies will have to make sure that the most promising and impactful innovative technologies become the most financially attractive and competitive for business.



Technology Mapping



4. OUR IMPACTS AND AMBITIONS

Process Industries are crucial components of numerous **value chains which deliver useful services to our society and to European citizens**: the materials we produce ultimately contribute to transport passengers or freight, to provide shelter and housing to families, to offer comfortable working spaces, to produce and preserve food and beverages – amongst many other benefits.

The R&I efforts of Process Industries under the SPIRE 2050 Vision ultimately want to **enhance and – wherever possible – enlarge the underlying value to society** generated by our businesses while achieving overall **carbon neutrality, moving towards zero-waste-to-landfill and enhancing the global competitiveness of our sectors**.

Carbon neutrality, circularity and competitiveness are not independent ambitions. On the contrary, it is clear that carbon-neutral and circular economy strategies (notably supported by digital technologies) that lead to deep cuts in greenhouse gas emissions from process industries, have a multiplier effect down entire value chains and generate innovative and competitive business models.

This “value-to-society” mindset will guide our transformation and our level of ambition. It opens new territories of innovation opportunities and can thereby help give birth to the next generation of European Process Industries. This approach addresses the reduction of environmental impacts per unit of material used but also encompasses the enhancement of energy and resource efficiency in the final product and the optimisation of the use of final products to deliver equivalent or enhanced services to society.

The change to which we want to contribute is extremely ambitious. **The following pages present our quantitative ambitions up to 2050.**

- > The transformation of the EU Process Industries in relation to the SPIRE 2050 Vision can be observed through **‘Transformation Trackers’**, using official data sources. The Trackers will allow SPIRE to trace the extent to which its vision for the process industries is being realised and identify areas where greater R&I efforts may be required. The Trackers will provide SPIRE with the regular data it needs to take an agile, evidence-based, and mission-driven approach to R&I over the coming decades.

In addition, SPIRE will use the Transformation Trackers to measure the process industries’ contribution to broader EU goals. This will allow SPIRE to enrich a continuous dialogue with policy makers and SPIRE stakeholders to further align our Vision with the global challenges and policies of the European Union and the Member States.

- > The direct impact of SPIRE projects will be monitored through **‘SPIRE Impact Indicators’**, in relation to the objectives of the SPIRE 2050 Vision, Horizon Europe using project internal data. This process will be integrated within SPIRE’s existing monitoring procedures in coordination with the European Commission.



SPIRE

Sustainable Process Industry through
Resource and Energy Efficiency

Ambition 1: Bridging the climate technology gap

SPIRE WILL ENABLE THE DEVELOPMENT OF THE REQUIRED SOLUTIONS TO FULLY CONTRIBUTE TO THE ACHIEVEMENT OF EU CLIMATE POLICY TARGETS

SPIRE wants to bridge the technology gap existing between the level of decarbonisation achievable with already available and economically affordable technologies and the Paris Agreement objective of overall carbon neutrality by 2050. SPIRE wants to enable the Process Industries to **fully contribute** to the transition of the global economy towards a “well-below 2 degrees” scenario.

R&I actions need to develop the scale of operations required through, for example, larger demonstrators. SPIRE calls for instruments that allow comprehensive bridging of the technology gaps and scaling up the impact for the environment and society. This will require developing the following types of projects under Horizon Europe:

LIGHTHOUSE PROJECTS

Setting a clear signal of the direction that industrial R&I should move towards.

LARGER-SCALE FLAGSHIP PROJECTS

Demonstrating the industrial feasibility of system solutions with strategic potential, high impact and considering higher TRLs. Demonstrators are required to test technologies at scale and explore integration with existing processes to better understand the techno-economics which will help further de-risk future investment and set the right framework for competitive technology application in Europe.

TRANSFORMATION TRACKER: ABSOLUTE CO₂eq EMISSIONS COMPARED TO 1990

By 2015, the SPIRE sectors had achieved a 37% reduction in absolute annual CO₂eq emissions compared to 1990. The remaining reduction potential with available and economically competitive technologies today is very limited.

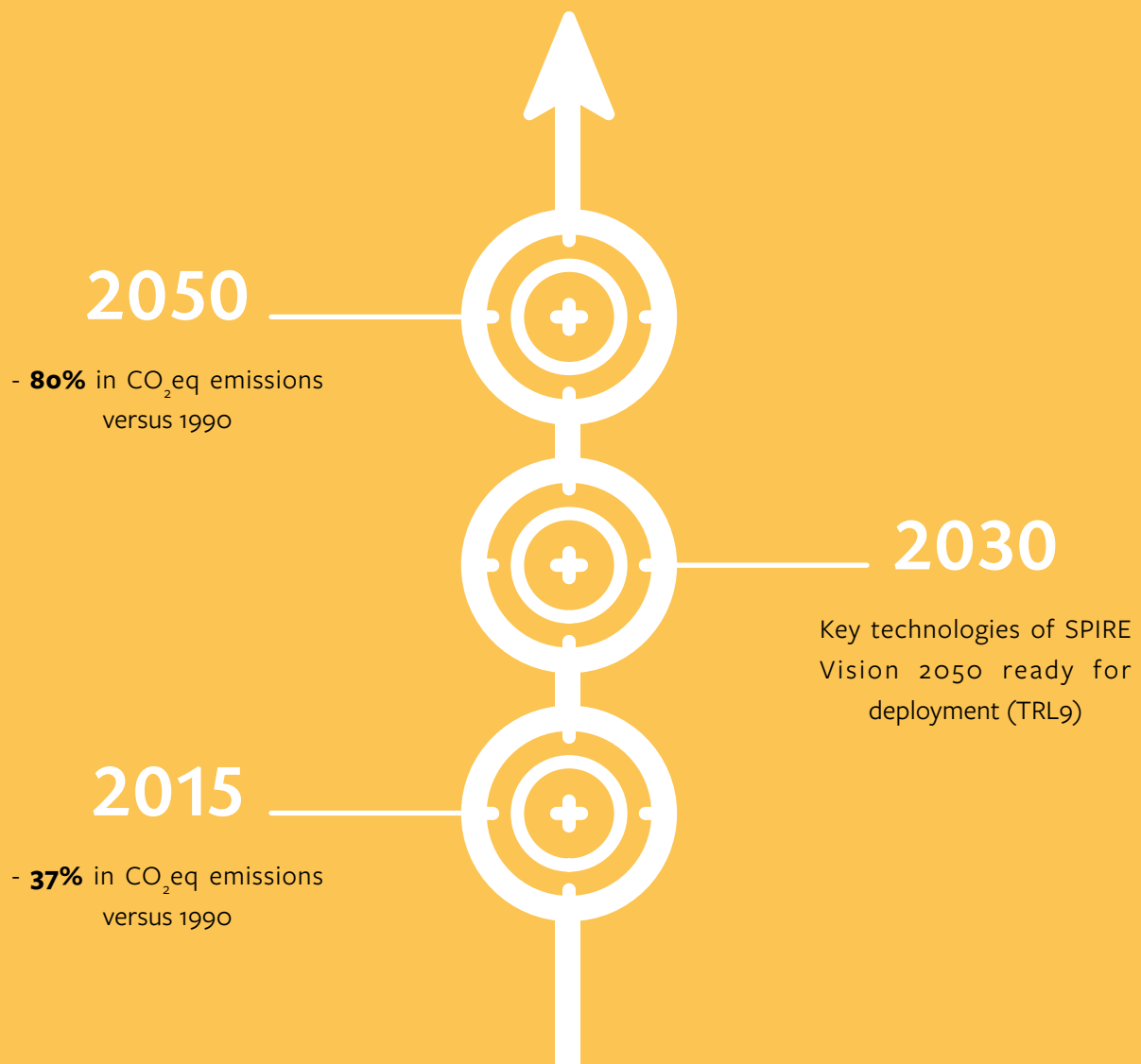
The **ambition of SPIRE is to push up the Technology Readiness Levels of the key technologies recognised in our Vision towards TRL9 by 2030**: by this time, we need to have these technologies ready and commercially available for deployment by large companies and SMEs in order to fully contribute by 2050 to the objective of carbon neutrality at the level of the overall economy. Referring to the current EU Climate and Energy targets, Process Industries ambition is to achieve a

80% reduction in absolute annual CO₂eq emissions compared to 1990⁷ by 2050.

Beyond technological efforts, this level of ambition will require an enabling legal framework, sufficient low carbon energy supply at a competitive price and new CO₂ transport and storage infrastructure across the European Union.

By making low carbon technologies commercially available for other industries, the success of SPIRE will not only enable the transition of European industrial facilities towards carbon neutrality. It should also result in their deployment beyond EU borders and help achieve a “well-below 2 degrees scenario” at global level.

⁷ This “minus 80%” ambition takes into account CO₂eq emission savings achieved through symbiosis effects between Process Industry sectors as well as the use of CO₂ from other industries in our own processes



POTENTIAL SPIRE IMPACTS

Further dialogue with the European Commission is required to define the metrics (and targets) measuring potential SPIRE impacts. Our ideas are presented below, for illustration purposes:

- > Number of large demonstration projects (lighthouse/flagship) in key areas of SPIRE 2050 Vision (e.g. CCU, electrification etc).
- > Mean proportional CO₂eq saving targets for these projects (compared to current practices).
- > TRL increase of key technologies recognised in the Vision.

Ambition 2: Process industries as “Hubs For Circularity”

SPIRE WILL DEVELOP THE REQUIRED SOLUTIONS TO MOVE TOWARDS ZERO-WASTE-TO-LANDFILL FOR RECYCLABLE / RECOVERABLE WASTE

SPIRE targets a maximum efficiency in the use of every resource.

Our ambition is to mobilise private and public sector in order to create Industrial /Urban Hubs For Circularity across Europe by 2050.

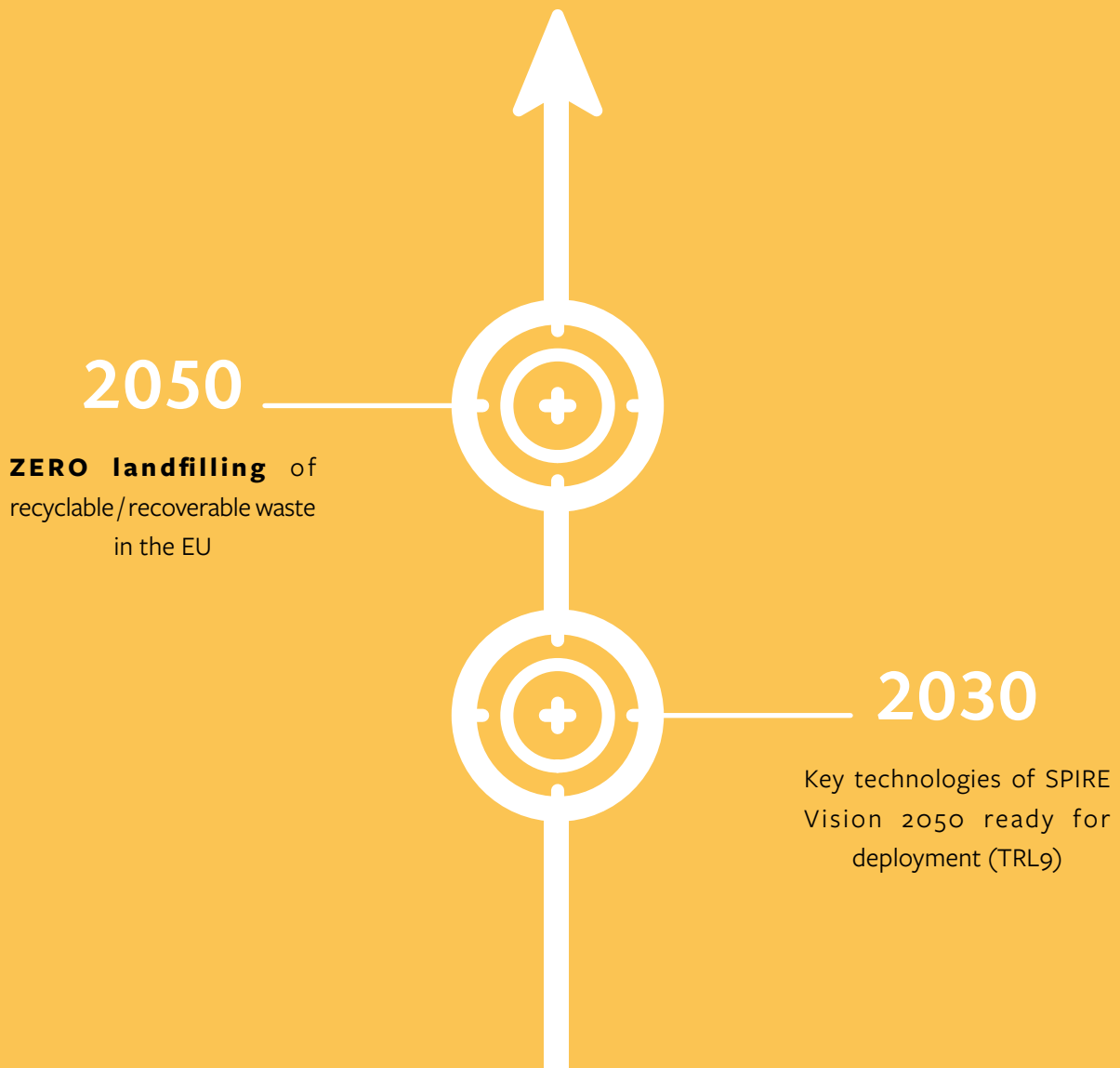
HUBS FOR CIRCULARITY

A **“Hub For Circularity”** is defined as a cluster of interconnected industrial (large companies and SMEs) and/or public facilities within a given geographical area, which collectively achieve a demonstrable level of circularity in their use of resources.

TRANSFORMATION TRACKERS: RECOVERABLE/RECYCLABLE WASTE TO LANDFILLS

The multiplication of these “Hubs” will further drive our economies towards a “zero-waste-to-landfill” ambition for recyclable/recoverable waste in the European Union – to be achieved by 2050 at the latest.

This paradigm shift will require validated and competitive technologies by 2030, as well as an enabling and consistently well-enforced regulatory framework.



POTENTIAL SPIRE IMPACTS

The transformation of European society towards more circularity requires the multiplication of **“Hubs for Circularity”** throughout the continent.

SPIRE has the ambition to establish 50 Hubs for circularity by 2050, of which 15 should be in place by 2030. This development will require collaboration and support between public authorities and the private sector, as well as appropriate and enforced regulations at all levels (EU, Member States, regions, cities).

The mean proportional performance of these hubs (compared to current practices) could be monitored in terms of (indicative list): non-renewable primary material savings, waste diverted from landfill/incineration/discharge, and/or fossil energy saving. Further dialogue with the European Commission is required to define the right metrics (and related targets) measuring SPIRE potential impacts.

Ambition 3: Globally competitive EU process industries

SPIRE WILL SEEK TO MOBILISE PRIVATE AND PUBLIC STAKEHOLDERS TO BOOST NEW INVESTMENT OPPORTUNITIES FOR SMEs AND LARGE INDUSTRIES

SPIRE's ambition is to boost investments realised in Europe and, therefore, to contribute to the reindustrialisation of the continent. Technologies alone, therefore, are not sufficient. Their effective deployment requires a highly qualified and skilled workforce and talented people with a bold entrepreneurial mindset. It also requires sufficient financing.

SPIRE will help define the required framework conditions for globally competitive EU Process Industries, notably related to:

Ambitious financing instruments leveraged by private investment.

An enabling industrial policy fostering competitiveness at global level and within the EU.

Regulations and standards supporting the transformation we want to see by 2050.

Process Industries, EU authorities, Member States and Regions must act together to stimulate investment, improve skills, empower industries and ensure that all citizens and regions benefit from the transition.

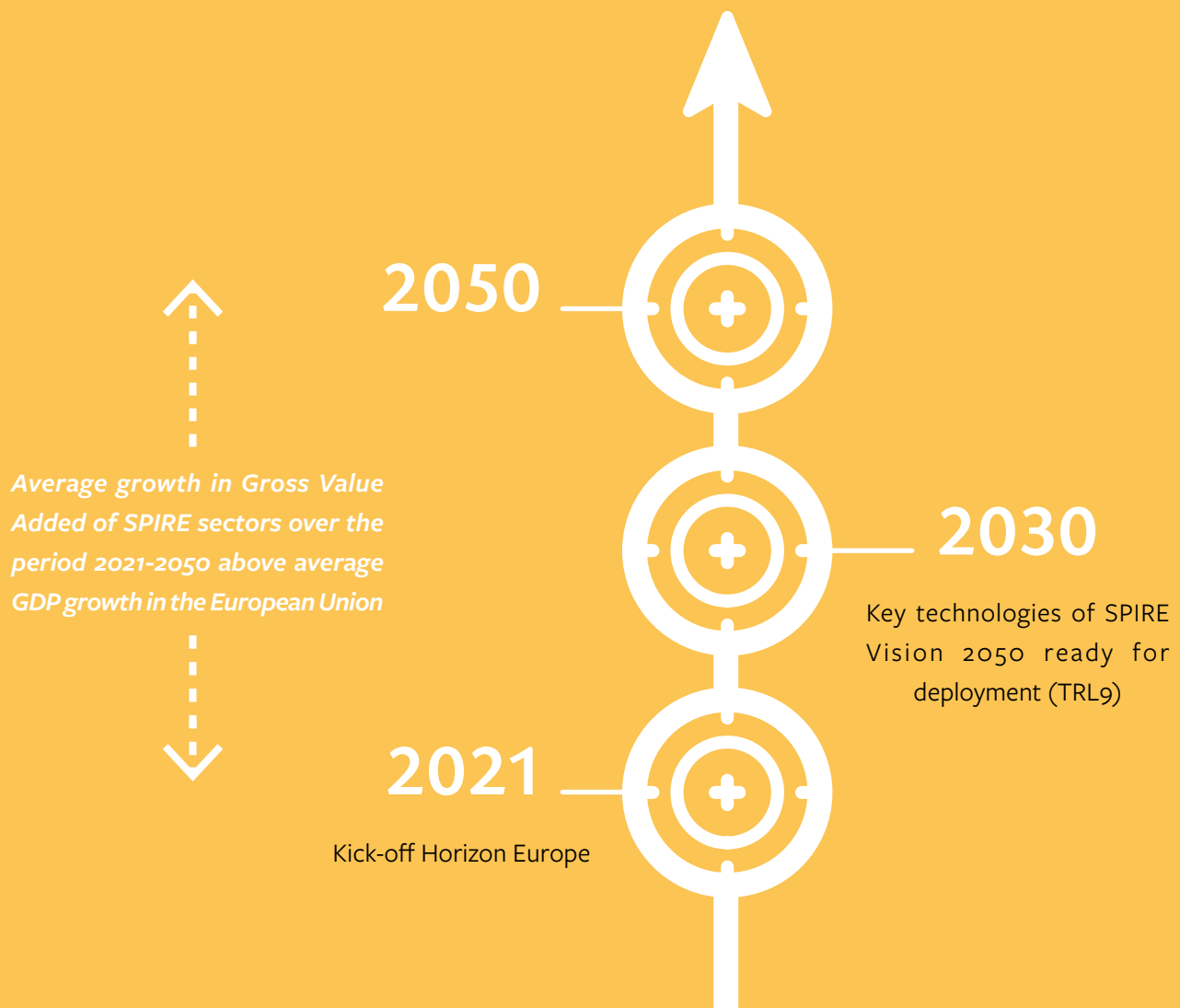
TRANSFORMATION TRACKER: GROWTH IN GROSS VALUE ADDED

Research & Innovation efforts will deliver and validate the technologies European Process Industries need to thrive in a sustainable way. Our ambition here is to have the key technologies recognised in the SPIRE 2050 Vision ready for deployment by 2030 so that we can achieve an **average annual growth in the Gross Value Added of SPIRE sectors above the average EU GDP growth** over the whole period 2021-2050.

Over the same period, SPIRE sectors also want to see improvement in the **EU trade balance** for our materials and products.

SPIRE intends to pioneer integrated monitoring and reporting approaches by assessing the **total “value to society”** generated by SPIRE sectors, monetising positive and negative externalities. This approach will help estimate the actual triple bottom-line impact of EU Process Industries (on business, planet and society) and to maximise it.

The **“job multiplier effect”**, assessing the ratio between total jobs created (including indirect and induced jobs) and direct jobs created, will also be monitored. This should be further enhanced over the period towards 2050.



POTENTIAL SPIRE IMPACTS

Further dialogue with the European Commission is required to define the metrics (and targets) measuring potential SPIRE impacts. Initial ideas are presented below:

- > Number of key competitiveness innovations demonstrated at scale that dramatically improve earnings, open new markets, or advance the quality and flexibility of production.
- > Mean proportional improvement to earnings (compared to current practice) delivered by the relevant projects.
- > € value of new markets for EU process industries that the relevant projects provide access to.
- > Possible SME indicator: SME impact of the projects in terms of employment, turnover, and/ or start-ups.

5. FURTHER CASE EXAMPLES OF R&I UNDER SPIRE 2050

This document includes some brief descriptions of Case Examples of technological developments needed through SPIRE projects, or groups of projects. More detailed versions and further sector-specific case examples can be found on the SPIRE [website](#).

CASE EXAMPLE

Energy efficient comminution technologies

New comminution technologies will be developed to decrease energy demand and tackle the rising complexity of material feedstocks. Innovative plant designs based on efficient machinery and virtual modelling, new measurement technologies and further digitalisation of process and product control processes need to be studied and deployed at scale. These developments could reduce energy demand by up to 50% and enhance the ability of process industries (e.g. cement, lime, minerals) to use a broader variety and larger volumes of alternative resources.

CASE EXAMPLE

Building materials as CO₂ sinks for permanent storage

Concrete, recycled concrete aggregates, and lime-based mortars all have a demonstrated ability to chemically bind CO₂ from the atmosphere. Further research and demonstration projects are needed to optimise and accelerate the process and better monitor the achieved storage while maintaining/enhancing functional properties.

CASE EXAMPLE

Energy efficient high temperature treatments for shaped refractory products

The shaping, drying and final temperature treatment of refractory products are energy intensive processes for which new solutions are to be developed. The use of 3D printing technologies as well as microwave drying techniques represent two processing techniques which can enhance both energy and material efficiency.

CASE EXAMPLE

Breaking the walls between Process Industry sectors

The multiplication of Industrial Symbiosis models still faces a long list of technological and regulatory challenges: notably related to the free exchange of data between companies, the establishment of common terminologies between sectors, buffer/storage solutions to address seasonal variations in material and energy flows as well as enabling (waste) regulations and standards. The cross-sectoral nature of SPIRE makes it a unique vehicle to explore, identify, develop and pilot practical solutions to these challenges.

CASE EXAMPLE

Moving to a carbon-free electrolysis process for Aluminium (smelting) integrated into a renewable-intensive grid mix

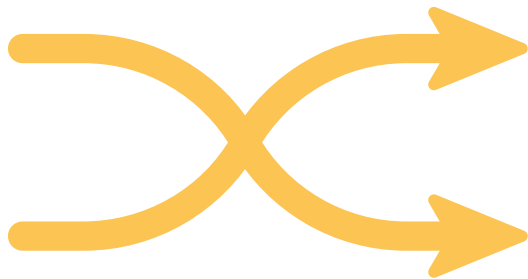
Today, primary aluminium production is an electricity-intensive process requiring stable current and generating CO₂ and other greenhouse gases emissions through the use of carbon anodes. In the future, the primary aluminium production will shift to a carbon-free smelting process. This requires the development of new and optimised pot lines for enabling the use of electricity from renewable-intensive grid mixes, by allowing power variations, e.g. acting as an electricity buffering consumer industry. Building on ongoing R&I activities, the deployment of pilot and semi-industrial lines is critical to secure the proper validation of the technologies, including solutions for retrofitting existing smelters.



6. SPIRE IN THE EU INNOVATION LANDSCAPE

SPIRE and the EU's funding and financial instruments:

We believe that Horizon Europe needs to set ambitious goals for making a substantial leap towards the objectives of the Paris Agreement and tackling societal and industrial challenges. It is equally important that industry leverages this ambition through its commitment and shared vision. Having demonstrated its dedication throughout the period of the Horizon2020 framework programme, SPIRE calls for **flexibility and interoperability of research and innovation funding instruments in Europe.**

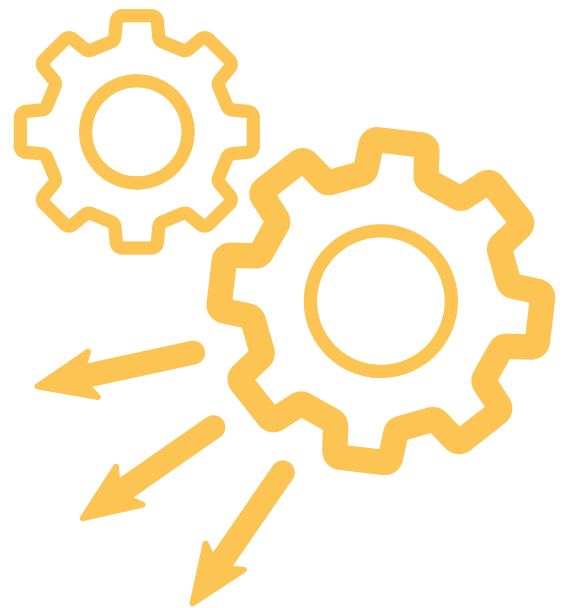


FLEXIBILITY

*Funding instruments should be flexible and able to **finance flagship projects to higher TRLs** (e.g. TRL8, or even TRL9) to meet the industry's leverage in cases where this may lead to achieving substantial impact and **trigger faster deployment at real scale**, for instance when pioneering a technology from Europe to ensure leadership in global markets.*

INTEROPERABILITY

*The possibility of **continuing** successful projects by providing **direct additional funding** that ensures delivery and deployment of project outcomes and reaching a broader impact*



The commitment of SPIRE's stakeholders to its vision and objectives has been demonstrated through their bottom-up approach, driven by a need and desire to contribute and to grow in Europe. We therefore call for a **continued framework that allows for a real bottom-up approach** where industry and research organisations have a say in defining priorities and topics for work programmes under Horizon Europe through a close collaboration with European and national policymakers and a close dialogue with civil society.

Cross-sectorial and cross-border cooperation is expected in supporting projects that tackle European challenges. This should be done by harmonising funding requirements and establishing clear links amongst cPPPs, additional European funding mechanisms and smart cities, and regions, etc. Moving closer towards a **“one-stop shop” concept** for innovation and investment support for industry and researchers would simplify the application process and empower stakeholders to maximise the impact of their work.



SPIRE connected across borders and to citizens

The nature and the size of the process industries' plants / facilities make them an important physical, economic and social pillar of the region and country where they are placed. Therefore, the competitiveness and sustainability of such industries and companies represent a good factor for the competitiveness and sustainability for European countries, regions and citizens.

SPIRE welcomes a closer collaboration of EU Industrial Partnerships with Member States and with regions. At regional level, the connection with Smart Specialisation Platforms, such as **S3PIndustry** or **S3PEnergy**, is to be explored. SPIRE established a dialogue with different Member States when its SPIRE2030 roadmap was created, resulting in alignment with policies on decarbonisation, circular economy and industrial symbiosis within the

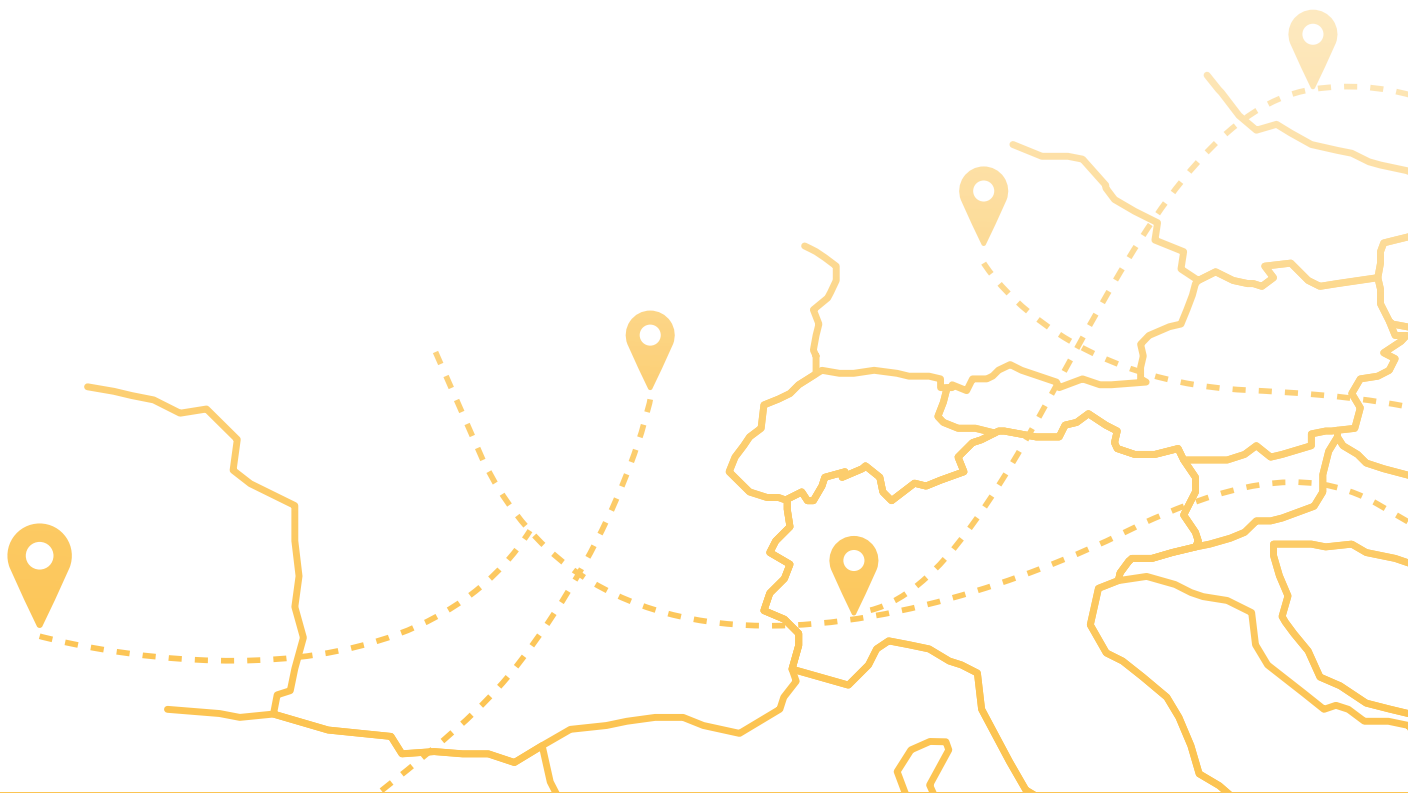
EU-28 framework. We also collaborate with Member States through SET PLAN Action 6 (Energy Efficiency). The SPIRE 2050 Vision shows our willingness to align with national and regional policies further through, for example, the Hubs for Circularity, and we are open to launch conversations again with Member States before we fully develop our new roadmap.

Any transformation in our industrial processes will have a direct benefit for citizens and the link with civil society can be an opportunity for a wider alignment to meet the Climate Challenge and Circularity goals. The connection and collaboration with civil society specialising in these two policy areas is already being established for the development of SPIRE 2050 Vision and future roadmap.

Framework conditions for competitiveness

Dedicated efforts to retain our research talent, attract foreign expertise and investment, and translating innovation into tangible welfare for European citizens should be supported by a **predictable and enabling regulatory and financing framework**. This will provide comprehensive conditions to develop innovative products and processes, application of novel technologies and enable breaking through innovation bottlenecks.

The transformation we want to see should result in a more sustainable and globally competitive European Process Industry that brings benefits to the European economy, environment and society.



Connection to other partnerships and instruments

The SPIRE cPPP has defined its scope and Vision 2050 as a vital complement to the existing initiatives and partnerships in the European R&I landscape. SPIRE has established docking points with other Partnerships such as the BBI JU, through a joint working group that aims at exploring complementarities and synergies to maximise impact. EIT Raw Materials is a member of A.SPIRE and close collaboration is established through their participation in SPIRE Working Groups. Broader synergies on the results of SPIRE projects on skills and jobs profiles are being developed to maximise impact and other options to collaborate in other areas, such as circular economy, are being discussed.

Research cPPPs connect the vertical value chains. Process industries within SPIRE, for example, produce materials and composites that directly support improvements in

the production of cars or other final products (FoF or EGVI stakeholders) or in the construction of buildings (EeB stakeholders) and continuous dialogue and joint actions or events are developed with them. Further cooperation with the digital cPPPs is envisioned to meet the goals of digitisation of the EU Process Industry. The 2050 Vision establishes connections, for example, with Big Data and Cybersecurity cPPPs or with the power industry and hydrogen producers. A mapping on further relevant synergies to be established will be developed at roadmap level.

We call for even **stronger and facilitated collaboration among European partnerships and other initiatives, including the participation of Member States.**







SPIRE 2050 VALUE PROPOSITION

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

TOWARDS THE NEXT GENERATION
OF EUROPEAN PROCESS INDUSTRY

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