SPIRE

SUSTAINABLE PROCESS INDUSTRY

European Industrial Competitiveness through Resource and Energy Efficiency

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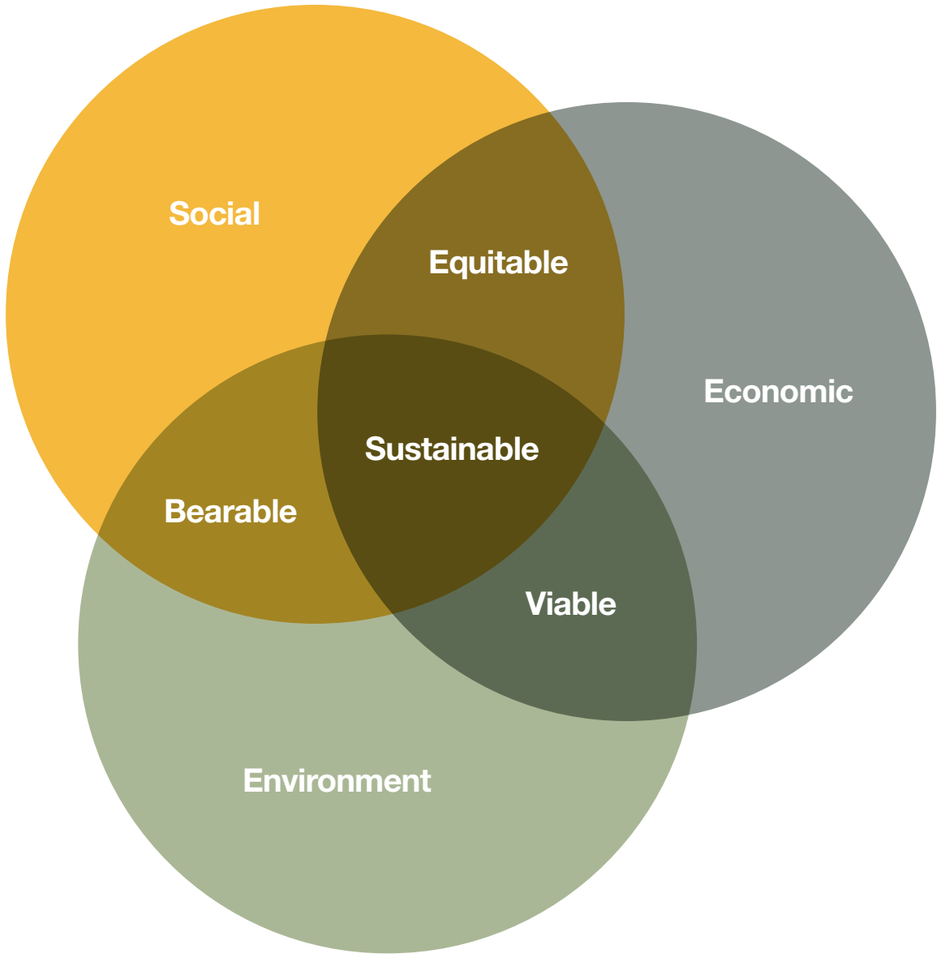
Brundtland Commission's definition of sustainability:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[1].

Sustainability centres around three elements: economy, environment and society.
Only where all three overlap is a product or service truly sustainable.



This Research & Innovation Public-Private Partnership (PPP) proposal, Sustainable Process Industry through Resource and Energy Efficiency (SPIRE), has the objective to develop the enabling technologies and solutions along the value chain that are required to reach long term sustainability for Europe in terms of global competitiveness, ecology and employment.

The SPIRE PPP will be instrumental in addressing the Grand Societal Challenges defined within EU 2020 Agenda through the broad correlation it has across various flagships initiatives (Innovation Union, Resource Efficient Europe, Industrial Policy for the Globalisation Era). In the latter, the Commission specifically addresses the need for public-private collaborations to ensure uptake of resource and energy efficiency innovations – "in the context of the discussion on future research Public-Private Partnerships, consider an Energy-intensive Industries Low Carbon Implementation initiative, bringing together the relevant technology platforms with EU and Member States, to ensure the appropriate R&D, financing and deployment strategies for low-carbon production"[2].

The process industry is uniquely positioned to drive this initiative as it transforms raw material feedstocks to intermediate and end-user products and thus sits at the core of every value chain. There it fulfils the enabling role for improving competitiveness whilst drastically reducing resource and energy inefficiency and the environmental footprint of our industrial activities. A substantial resource efficiency improvement has been achieved in industry over the past years[3] and technological breakthroughs are needed to pass beyond current day limits. The process industry has been at the foundation of the European Economy, creating global leadership as it initiated the first and second Industrial Revolutions. It is still in many areas a global leader, however it is losing its position due to ever increasing global competition with associated loss in employment, intellectual capacity and economic impact. **This initiative is essential to rejuvenate the European industrial base and make the paradigm shift of decoupling economic growth from resource impact.** It is uniquely positioned to support the ongoing PPP initiatives (Factory of the Future, Green Cars and Energy-efficient Buildings), through an essential complementary Value Chain coverage to ensure the resource effective transition in key enabling technologies that "feed" these PPPs' objectives.

The Resource and Energy Efficiency Partnership (REP) is the driver behind the SPIRE PPP proposal, building upon the collective expertise of more than 10 major industry sectors - all with strong connections to process manufacturing. The proposal can count on the engagement of REP in the further definition of a PPP work package structure, multi-year roadmap and consortium structure. It will, for the first time, bring together all actors along the value chain - from different types of feedstock through industrial transformation into intermediate and end-products. **The proposal pursues a comprehensive innovation concept, which whilst including technological progress, also encompasses novel business models, design, branding and services. It includes public sector and social innovation concepts as well as commercial innovation.**

The SPIRE PPP will involve large corporate, top-academia and high-tech SMEs to develop innovative technologies and breakthrough materials of the future that will modernise the European industrial landscape in becoming a competitive process partnership, as a global solution provider towards a clear set of breakthrough ambitions related to crucial resource efficiency targets. These solutions will then become available for a wider range of EU SMEs or currently less performing sectors and entrepreneurs making the EU process industry as a whole the most competitive at global level. Based on thorough life cycle analysis and aggregated across all sectors of the process industry we envisage the following ambitions.

1. *A reduction in fossil energy intensity of up to 30% from current levels by 2030 through a combination of, for example, cogeneration-heat-power, process intensification, introduction of novel energy-saving processes, and progressive introduction of alternative (renewable) energy sources within the process cycle.*

2. *By 2030, up to 20% reduction in non-renewable, primary raw material intensity versus current levels, by increasing chemical and physical transformation yields and/or using secondary (through optimised recycling processes) and renewable raw materials. This may require more sophisticated and more processed raw materials from the raw materials industries. A full life cycle cost analysis is required to consider all effects of using secondary and renewable feedstocks (e.g. water usage) and to prove the sustainability advantage.*

Both these aspirations will make a significant contribution to the political and societal objectives of drastic efficiency improvement in CO_2-equivalent footprints[4].

The technology roadmap will be designed around two key priorities; energy efficiency and non-energy resource efficiency (e.g. materials, water, waste, etc.) for the process industry. For each of these priorities, three areas of development have been defined; leverage existing technology beyond current practice, new innovations in single sectors and across sectors. SPIRE PPP will also include an economic feasibility study and recommendations for market uptake.

The global requirements for drastically increased resource efficiency is seen by REP as an opportunity. It will be used to turn around a decreasing trend in European competitiveness of the process industry and position Europe as a global leader. The value chain approach and the active role of industry in definition of the PPP proposal ensures that there is commitment in execution of the PPP, and it will also facilitate an effective uptake of the results of the PPP in the market. Europe will merit from the PPP as in return industry will pursue exploitation of generated intellectual property and technology first in Europe. Also companies receiving public funding should preferentially involve EU lead customers and/or suppliers (preferentially SMEs). The public sector (EU and Member States) will have to play an essential role in design and implementation of support policies and regulations.

The foreseen breakthrough developments will stimulate entrepreneurship in Europe, create more jobs both in the process industries (more interesting and higher quality jobs), the research community (world class research) and high-tech SMEs (new eco-efficient process technologies) by creating new markets. At the same time, citizens' quality of life will improve by building a greener, more efficient and better society for Europe.

This Public-Private Partnership (PPP) proposal, Sustainable Process Industry through Resource and Energy Efficiency (SPIRE), takes on two of the most urgent European challenges towards 2030. It targets the critical need to increase the competitiveness of Europe in a global market whilst drastically reducing resource and energy inefficiency and the environmental impact of our industrial activities.

This concept of decoupling economic growth from resource impact, lies at the core of this PPP, and will be achieved by a coherent set of actions which are based on a sound analysis of knowledge, technology and economical, competitive and societal barriers that we need to overcome to realise our objective: "to develop enabling technologies and solutions along the value chain required to reach long term sustainability for Europe's process industry, both in terms of global competitiveness, ecology and employment".

1.1 REP Partnership

Resource and Energy Efficiency Partnership "REP" is an informal group comprising a broad range of major European Industry Associations and European Technology Platforms (see Table 1). The main technology platforms are ESTEP – the European Steel Technology Platform and SUSCHEM – the European Platform for Sustainable Chemistry. Two complementary platforms, WssTP and SMR, are also associated. The European associations are EUnited (European Engineering Industry Association), the Industrial Minerals Association, Glass for Europe, the European Coil Coating Association, the European Copper Institute, the European Aluminium Association, Eurométaux, the Confederation of European Paper Industries CEPI, the European Ceramic Association, CEMBUREAU, the European Cement Association and the Nickel Institute. The position paper addresses energy and resource intensive industries which produce materials transformed at a further stage by downstream industries such as automotive, construction, power industry, etc., into products and equipment (cars, building, houses, etc.). The group aims to promote co-operation between industrial sectors, to seek solutions in industry processes to promote resource and energy efficiency.

These process industries represent a major part of the manufacturing base in Europe (EU27), together including more than 450 thousand enterprises. They have over 6.8 million employees, generating more than €1,600 billion turnover. As such, REP represents 20% of the total European manufacturing industry[1], both in terms of employment and turn over. The European industry accounted for more than a quarter of total energy consumption in 2010 in Europe[5] with a significant portion of that used within the process industry. This represents both an opportunity and responsibility for energy efficiency. The industrial sectors represented in REP built the founding basis of the European Economy, leading the region to tremendous prosperity and progress as they initiated the first and second industrial revolutions. Whereas the REP industrial sectors still generate considerable employment and an impressive turnover in Europe (EU27), the overall global competitiveness of these key European industrial sectors is declining.

ESTEP - European Steel Technology Platform	SusChem - European Technology Platform for Sustainable Chemistry	WssTP - European Technology Platform for Water	European Technology Platform for Sustainable Mineral Resource
EUnited - European Engineering Industries Association	ECCA - European Coil Coating Association	CEMBUREAU - The European Cement Association	Cerame-Unie - European Ceramic Industry Association
EUROMETAUX - European Association of Metals	CEPI - Confederation of European Paper Industries	Nickel Institute	IMA - Industrial Minerals Association
Glass For Europe - Building, Automotive, Solar-energy Glass	European Copper Institute	European Aluminium Association	

Table 1: Partners in 'REP'

1.2 Objectives

The overarching objective is to better understand and develop the role of the process industry in resource and energy efficiency, to meet sustainable development needs. Sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". We position sustainability around three main elements: economy, environment and society; only when all three overlap, is a product or service sustainable. The detailed objectives are:

- *To address competitiveness, i.e. a strong and competitive value chain of production, with at the core the process industries*
- *To develop, via research, innovation and knowledge exchange in the value chain, new solutions to improve resource and energy efficiency in industry*
- *To develop and deploy solutions enabling to reduce the carbon footprint of fabricated mass products such as cement, ceramics or glass*
- *To develop solutions that demonstrate the advantages of industrial co-operation, and help regulators optimise the regulatory, financial and organisational framework for industry*
- *To explain and promote the current and future potential role of industry and associated value chain in addressing the current challenges of employment creation, sustainability and energy policy*
- *To provide a channel for a broad coalition of industry interests to dialogue with the EU institutions on methods of improving resource and energy performance*
- *To include the trade dimension, that is develop solutions taking into consideration the global context, including the effectiveness of policies and impact on the three elements of sustainable development*
- *To raise understanding and awareness among all actors (including industry and policy makers) about the actual and future role of the modern process industry, to crucially achieve declared aims via optimised framework conditions*

2.1 Process Industries in the Value Chain

The manufacturing industry can essentially be classified into two main categories: process industry and discrete manufacturing. The process industry transforms feedstock resources during a (typical) (semi)continuous conversion into a new material that has significant different physical and chemical performance as the starting substance. This material is then usually shaped by discrete manufacturing into an end user product or intermediate component; often it requires combining several different discrete manufacturing operations to come together into a consumer product. For example iron ore (combined with other elements) is transformed by the steel process industry into e.g. steel coils and bars, which are subsequently formed and welded together into a car body-in-white (BIW) in a discrete step by automotive manufacturers. In a similar sequence fossil or bio-based feedstocks are transformed by the chemical process industry into e.g. plastics. These plastics get formed by injection moulders into various car components e.g. an instrument panel. The instrument panel and BIW are united (together with many other components) by the automotive manufacturers in the final discrete assembly step. A schematic overview of the complete value chain is shown below. (Figure 1)

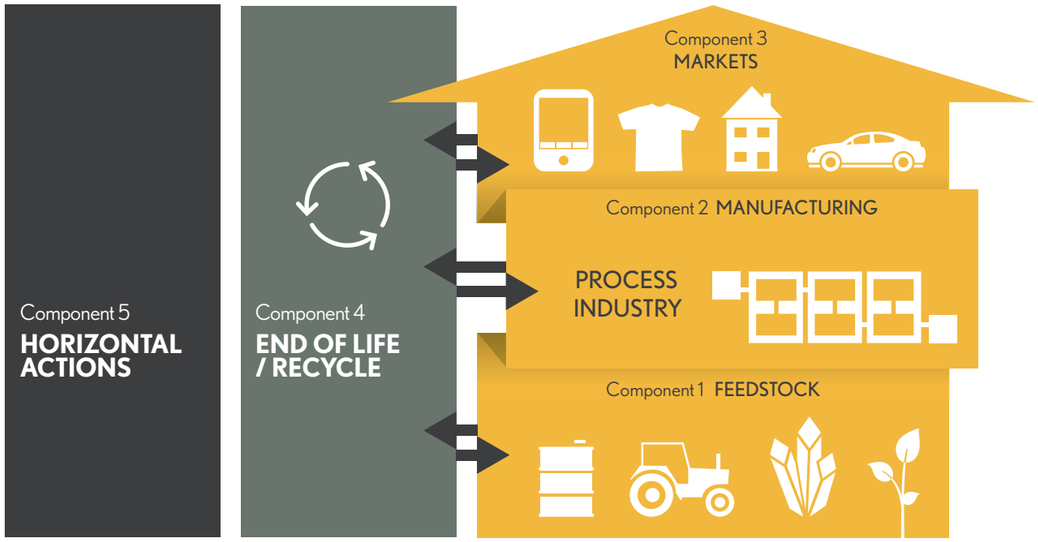


Figure 1: Value Chain schematic

The SPIRE PPP will for the first time bring together all actors along the full value chain – from different types of feedstock, through industrial transformation into intermediate and end-products. The target is to drastically reduce the environmental footprint and increase competitiveness of industry by "doing more with less". To do this successfully one has to consider all the major components in the value chain (see Figure 1); feedstocks and their source, the conversion processes, the intermediate and/or end-user needs and certainly also the waste streams. It is thereby important that both the separate components as well as especially the integrated holistic view are taken into account, including significant horizontal issues.
At the core is the process industry, one of the key industrial sectors in Europe, and therefore an essential precursor for improving competitiveness and sustainability for almost all industrial value chains and applications, from automotive to construction, from renewable energy applications to lighting, aeronautics, health care and so on and so forth. This is why the Resource and Energy Efficiency Partnership is uniquely positioned to drive this initiative.

2.2 Research and Innovation

The process industries producing materials are at the roots of the European economy. The different industry sectors involved within the Resource Efficiency Partnership target the critical need to increase the competitiveness of Europe in a global market whilst drastically reducing resource and energy inefficiency and the environmental impact of our industrial activities. The process industries have made significant improvement to resource efficiency over the last 40 years, and progress has to be made further in order to pursue the goals of the EU 2020 strategy for smart, sustainable and inclusive growth.

Many sectors have reached technological limits[3], in particular for energy efficiency, and will not be able to make big steps forward without technological breakthroughs. But further improvements can be achieved through:

- The diffusion of knowledge and best practices within the different sectors, through internal and cross-sectoral approaches
- The incremental improvement of existing equipments
- The promotion of pilot and demonstrators to bring successful laboratory concepts into practical application
- The holistic approach of innovation along the value chain

2.2.1 Synergy and Leverage Opportunities for Innovation in the Value Chain

Many technological synergy and leverage opportunities exist for driving eco-efficient processing for 4 components shown in Figure 1.

Reducing virgin feedstock and primary fossil energy usage, while not loosing productivity, by changing the feedstock and energy sources, e.g. renewable energy and increased proportions of bio-based feedstock and end of life feed-streams. This requires new collaborations with e.g. the energy sector and agriculture and forestry industries, within Europe and at an international level, to jointly overcome key bottlenecks for using biomass, EOL and renewable energy as a sustainable and reliable source in the process industry.

Resource and energy efficiency within processing must be improved by establishing new ways of utilising existing technologies/plants, as well as by implementing new and advanced process technologies leading to making more efficient use of existing resources. Industrial symbiosis[6] provides great opportunity, synergies between sectors and value-chains will be targeted, in order to deploy innovations and good resource efficiency practices from one sector and single value chains to others and speed-up CO_2 footprint reduction and increase impact of the PPP.

There are many opportunities for resource improvement down the value chain e.g. better insulation for buildings, energy-efficient lighting, and alternative fuel vehicles. Many of these efficiency improvement opportunities require new materials for which currently no production processes exist. Developing these new materials and processes clearly requires collaboration between the different players in the value chain (up and down) and across sectors.

Improving end of life (EOL) waste management and increased recycling towards zero-waste processes and cradle-to-cradle recycling has significant technological and non-technological challenges. Technology opportunities to consider include new methods for valorising EOL waste streams, chemical and mechanical recycling capabilities for reusing materials, design for reusing and recycling, ultimately enabling a significant reduction of the environmental impact. Intra- and cross-value chain collaboration is essential to enable the development and deployment of waste streams (industrial, EOL and others) as feedstock e.g. bio-waste from the food industry, reuse of precious metals from the high-tech industry etc. Better recycling (e.g. cradle-to-cradle) and waste handling to become a more resource efficient economy overall, will not only give Europe a competitive advantage, but also reduce its dependency on foreign sources for raw materials and commodities.

2.2.2 The Whole Chain of Innovation

The REP initiative wants to promote research and innovation, as well as the deployment of existing technologies and best practices, in order to get significant results by 2020. As shown in the following figure, the full innovation chain has to be covered, addressing basic and applied research, industrialisation and deployment.

Figure 2: Typical Innovation Chain in Process Industry

Industrial research and innovation (R&I) in Europe under this initiative should start to provide results into the market in resource efficiency in phase 3, and moreover in phase 4 and 5. Nevertheless deliverables will have to be made also in phase 0 to 2. One single project would likely not cover the whole chain but a few consecutive phases. This R&I would gather a wide range of stakeholders, from the process industries, academia, research centres and equipment suppliers. The up and downstream sectors generating feedstock and using and transforming our materials would have to be associated, in particular for the Life Cycle Assessment approaches and the increased recycling of products.

The SPIRE PPP will feature a coherent programme of research, development and innovation actions needed to enable the realisation of a set of well defined resource efficiency targets by 2030. The REP PPP will work with dynamic roadmaps which will enable identification of additional technological and non-technological requirements towards the realisation of the 2030 targets.

2.3 Access to Finance

Manufacturers have specific financing needs for capital investment but also for credit lines and cash flow:

- Create conditions for easier access to financing across the supply chain, with products addressing the needs of SMEs as well as large enterprises.

Industry depends on major capital investment with pay-back periods of 5 years or above:

- Develop financial solutions suited to longer pay-back periods, and improve investor knowledge about technology and performance.

Companies need financing for global activities and national export finance schemes are restrictive for global players:

- Improve funding from international financing sources (EIB, EBRD) and third parties (banks, equity financing companies), and negotiate for wider global OECD Agreement (on sustainable lending rules, adherence to country risk, payments, etc.) while clarifying environmental scope

2.4 Skills Development and Mobility

Industry and its value chain represent a potent source of employment. More consultation is required between actors in the value chain and in industry, employee and employer organisations as well as stakeholders to respond to labour market needs and improve green and environmental skills. Modern, adaptable and mobile working methods, including in operational maintenance are needed. Industry, academia and the whole EU Community are concerned to keep and promote breakthrough technologies in Europe and avoid loss of skills and brain drain. The European Community already benefits from several “people” programmes but more adapted and flexible programmes would facilitate training (e.g. simplified access rules, quicker response time).

The prime ambition joining the partners in REP is to improve the competitiveness of the European process industry through sustainable and resource efficient manufacturing. Many aspects can be taken into account when considering a sustainable process industry including materials, hardware, energy, skills, capital and more.

The SPIRE PPP’s primary focus is on “materials & energy” and has defined a clear and concrete set of compelling ambitions for these resource elements. Both the focus and associated ambitions have a strong political and public appeal. Especially on energy and materials the process industry can realise great contributions and play a key role in establishing a sustainable and competitive Europe. The human aspects associated with a sustainable process industry, like education, creation of new employment opportunities and overall well-being, are also included.

The overall objectives for this SPIRE PPP are defined after thorough consultation with many stakeholders within the partnership. Historical perspectives and achievements with regard to energy and resource efficiency were taken into account[7], also future economic growth is considered. Based on thorough life cycle analysis and aggregated across all sectors of the process industry we envisage the following challenging ambitions for the SPIRE PPP:

SPIRE PPP ambitions:

1. a reduction in fossil energy intensity of up to 30% from current levels by 2030 through a combination of, for example cogeneration-heat-power, process intensification, introduction of novel energy-saving processes, and progressive introduction of alternative (renewable) energy sources within the process cycle.
2. By 2030, up to 20% reduction in non-renewable, primary raw material intensity versus current levels, by increasing chemical and physical transformation yields and/or using secondary (through optimised recycling processes) and renewable raw materials. This may require more sophisticated and more processed raw materials from the raw materials industries. A full life cycle cost analysis is required to consider all effects of using secondary and renewable feedstocks (e.g. water usage) and to prove the sustainability advantage.

Both these aspirations will make a significant contribution to the political and societal objectives of drastic efficiency improvement in CO_2-equivalent footprints[8]. Potential improvements extend beyond “industry” to all indirectly supplied and dependent economic sectors such as transport, construction, water, electronics, etc.

Given the breadth of the industries involved, specific improvements for reduction of energy and resource efficiency will vary within each industry sector and subsector. Each sector’s prospect of achieving performance improvements depends on the inherent process and technology characteristics, the skilled application of levers such as financing, innovation and skills development, as well as socio economic aspects, as addressed in the original REP position paper.

The above objectives will have to be met by a dual approach that:

I. incorporates innovations (based on the adoption of existing solutions) into all stages of large scale existing value chain productions. For example retrofitting improvement and intensification programmes for existing assets (energy, fuel, chemicals, materials) or use of new resource and energy-efficient technologies in existing plants.
II. develops new innovative (enabling) technologies and industry processes, including integrated design of the whole industrial site, that will allow breakthroughs with regard to a resource efficient process industry. Examples are high efficiency small scale production, processes for recycling materials, new energy, advanced electrolysis, etc.

The innovation ambitions proposed within this partnership involve breakthrough changes but also imply an accelerated adoption of new methods that can speed up and improve the way we conceive, develop, produce and access (new) products and services. In addition to the stated objectives, these changes will create more jobs and at the same time also improve people’s lives whilst creating new markets and building a greener, more efficient and better society for Europe. This includes public sector and social innovation, as well as commercial innovation. The proposal here is therefore bold and ambitious, aiming to involve all actors and all regions in the innovation process and therefore fully in line with the forward thinking inherent in the European 2020 Strategy.

4.1 The Benefits of a PPP

There are many common challenges and synergistic opportunities between the process industries combined within the partnership. We serve common value chains and addressing their specific needs jointly will provide for products (end-user and intermediate), that have been designed with the full life cycle of the product in mind. Many of the partners share a dependency on energy and resource intensive processes, where the science that leads to superior technology is seldom industry specific. More could benefit from appropriate leverage across sectors of existing improvement solutions and joint development of new innovations. Also many commonalities exist in regards to gaps and bottlenecks related to lacking or flawed policies/ regulations and other horizontal issues. Resolving those with the cross-sectoral industry needs in mind will lead to broadly supported approaches. The key elements are:

Key elements:

- *It addresses the grand societal challenges as defined within the EU 2020 strategy.*
- *It will create new markets with large opportunities for Europe to be a world leader, create jobs and economic value.*
- *Collective expertise and engagement of major industrial sectors*
- *Stakeholders include research, academia, as well as industry, at European and national level.*
- *Interface for co-operation with other actors – finance, governments, etc.*
- *Cross-sectoral synergies*
- *Developing multiple annual strategic roadmaps*
- *Working close to markets and industry with real solutions*

The challenges and opportunities will be more extensively discussed in the next sections.

The SPIRE PPP is fully in line with the Europe 2020 policy initiative and also contributes directly to various flagship initiatives, in particular to the following:

- "An Industrial Policy for the Globalisation Era", in which the Commission specifically addresses the need for public-private collaborations to ensure uptake of resource and energy efficiency innovations – "in the context of the discussion on future research Public-Private Partnerships, consider an Energy-intensive Industries Low Carbon Implementation initiative, bringing together the relevant technology platforms with the EU and Member States, to ensure the appropriate R&D, financing and deployment strategies for low-carbon production"[2].
- "Innovation Union" and the three mutually reinforcing priorities defined in this flagship initiative: smart, sustainable and inclusive growth. The SPIRE PPP initiative has important links to various European Innovation Partnerships considered by the European Commission under this flagship including "Raw Materials", "Water Efficiency", and other initiatives such as the Key Enabling Technology Initiative, in which advanced manufacturing in particular is one priority.
- "Resource-efficient Europe", with its avowed aim to support the shift towards a resource efficient and low-carbon economy that is efficient in the way it uses all resources.
- "Energy Efficiency for competitive European Industry" the March 2011 Communication which addresses efficient generation of heat and electricity, including using energy recovery and saving potential, greater use of (high-efficiency) cogeneration, more efficient electricity and gas networks. The measures will increase the competitiveness of European manufacturing industry which accounts for about 20% of the EU's primary energy consumption. The Communication flags up lack of information and lack of access to capital and export prospects.
- Strategic Energy Technology Plan (SET Plan), which focuses on the performance of energy-efficient technologies, generating new solutions and facilitating wide-spread market take-up.

This broad correlation across the various flagships initiatives and different EIP proposals indicates that the SPIRE PPP can be instrumental in addressing the Grand Societal Challenges defined within the EU 2020 strategy.

4.1.1 Barriers

With this proposal of the SPIRE PPP, the partnership anticipates several bottlenecks to be dealt with. Next to technological barriers, which will be tackled by the innovations and new enabling technologies resulting from the PPP (see 'Innovations' section), also regulatory and some key critical non-technological barriers will need to be addressed in order to accelerate the deployment of the PPP enabling solutions to realise the EU 2020 ambitions.

Specific regulatory barriers to overcome are, amongst others, tax issues for e.g. sustainable bio-based product categories or problems caused by discriminatory effects of regulation and trade measures (e.g. import barriers into the EU). Also regulatory burdens with respect to permitting or the integration and alignment with local regulations should be addressed in order to accomplish quick (and standardised) procedures, resulting in more efficient market uptake and deployment. Treating waste within Europe, including cross border waste must be more competitive and economic than shipping waste to Asia. A similar approach has to be promoted for cradle-to-cradle recycling in order to facilitate the end-of-life material recycling into the process industry (e.g. scraps for metals). The public sector, including the EU and Member States will have to play an essential role in this partnership to facilitate and accelerate speed of take up of the innovations through specific policy and regulation development and targeted public procurement support.

Besides regulatory issues, other non-technological aspects and barriers should be considered as well. A major hurdle identified repeatedly in innovation progress is well known as the 'Valley of Death'[9,10]. The term reflects to the gap between the laboratory and the marketplace where often promising technologies do not find commercial application because of the prohibitive costs of building the first commercial-scale facility given the uncertainty of return on investment. The financial risk of the investment is too high without a solid demand in the market and/or fully verified technological performance. The risk of investment is simply much higher compared to investing in established markets and proven technologies. Furthermore, breakthrough innovation is hampered due to the fact that extensive value chain collaborations will be needed between innovators and conservative industries that may not be inclined to set-up joint research and development initiatives. Overcoming the collaboration and awareness gaps, as well as encouraging increased risk taking and joint approaches will require a publicly supported framework and additional financial incentives which go beyond the typical private investment reasoning.

Other non-technological barriers include e.g. excessive higher costs for e.g. biomass logistics, the lack of standardised tools for life cycle cost approaches, not having a level playing field for industry due to lacking standardised (global) certification and labelling schemes, insufficient logistic and business models as well as underdeveloped markets for reuse of waste streams, etc. Next to these, also the societal awareness and commitment from society will eventually determine (partly) the success towards a resource efficient Europe; think about the commitment with regard to recovery of post consumer goods, acceptance of bio-based end-products, etc.

4.1.2 Solutions

Concrete actions proposed with a PPP in regards to addressing non-technological barriers include amongst others:

Create the communication and education tools needed to build the expertise needed at all levels (operator to scientist) and across sectors to implement the technology innovations and accelerate future innovative thinking beyond today's paradigms around resource spending.

It includes amongst others: development of information, education and training structures, the utilisation of results, the promotion and dissemination of know-how and best practices involving all consumers, dissemination of results of the action and projects and co-operation with stakeholders through operational networks.

Standardisation of full Life Cycle impact ('Cradle to Cradle') approaches over the value chain for a harmonised environmental, economic and social assessment of novel solutions

Life Cycle Cost (LCC) and Life Cycle Analysis (LCA) assessments need to be structured and globally standardised methods for the quantitative environmental, economic and social evaluation of products (goods and services). The standardisation of LCC/LCA should endeavour the comparison of the overall performance of different products on an equal basis, ensuring a "level playing field" and help to avoid resolving one problem while creating others elsewhere by taking a comprehensive approach in one consistent framework. As such, it considers the entire life cycle of a product from e.g. the extraction of resources, through production/ processing, use, and recycling ('Cradle to Cradle'), up to the disposal of waste.

Taking for example environmental issues into consideration, it includes the quantifying of resources consumed as well as emissions into air, water and soil that can be attributed to the product and should provide in indicators of the product's contribution to a wide range of environmental problems such as climate change, toxic pressures, resource depletion and biodiversity.

Develop methodologies and tools for monitoring and to assess the most efficient allocation of resources in the value chain, including for cascading use of resources in all of the process industries.

Proper monitoring will be needed to establish the aggregated contribution and impact of the PPP's actions as well as to measure the impact of EU legislative and support measures. Cascading use of resources is becoming more and more important in order to be as "resource efficient" as possible. For each (waste) material it should be known in what kind of application it can have its highest added value. With respect to this, waste incineration for energy production is generally a straight forward solution. Yet there may be higher value applications to consider, unless though there is a market for such valorisation paths such solution becomes unfeasible. Strict methodologies and tools will therefore be required to help and determine the most efficient allocation of resources in the value chain, taking into consideration added value and valorisation capabilities.

Develop and standardise certification and labelling schemes for bio-based feedstock in order to create a level playing field towards the bio-based economy

One of the main objectives of standardisation is usually that everybody adheres to the same standards, i.e. the same procedures or product specifications. This may ease logistical procedures, facilitate trade, prevent consumer deception, improve quality and standardise the legal requirements in each country.

A standard procedure toward certification is needed so that "a third party" gives written assurance that a product, process or service is in conformity with certain standards e.g. on sustainability. Certification can be seen as a form of communication along the supply chain, from supplier to buyer, and should be completed by labelling to indicate that labelled products or processes are in compliance with verified standards. Currently a myriad of certification and labelling schemes and standards exist, creating confusion in the market and sometimes unjustified claims or impressions about sustainability. Globally defined and harmonised certification and labelling schemes therefore need to be established in order to establish trust and a reliable level playing field in the market.

It is the strength of the SPIRE Public-Private Partnership, having the right structure and stakeholders on board, involving all key players across the innovation value chain, borders, disciplines, sectors, policy areas and institutions, to be able to overcome the variety in bottlenecks simultaneously. The PPP structure is able to anticipate and strongly stimulate policy makers to improve the regulations and standards required, as well as to identify the most urgent (technological or non technological) needs and gaps to overcome so that it is ensured that any breakthrough is quickly brought to the market. These aspects and the ability of this PPP to step up R&D, co-ordinate investments and speeding up the process of bringing research and innovation breakthroughs to the market, will contribute to the enhancement of Europe's competitiveness.

4.2 Research and Innovation Roadmap

It is proposed to divide research needs into two priorities:

- Energy efficiency within the production of materials for the process industries
- Other resource efficiencies, e.g. raw materials, water, waste and by-products, bio-based feedstocks, Life Cycle Assessment, 3R approach (Reduce, Reuse, Recycle).

For these two priorities, we have identified three kinds of actions: deployment of key existing processes and technologies; new research and innovations area through a sectoral approach and through a cross-sectoral approach for energy and resource efficiency. Examples of technology involved are shown in Table 2 and Table 3.

Figure 3: Key R&I Areas

Table 2: Research and Innovation Example Topics – Energy Efficiency

Energy Efficiency		
Development of existing key technologies	Sectoral approach for research and innovation in energy efficiency	Cross-sectoral approach for research and innovation in energy efficiency
Benchmarking, best practices exchanges	New concepts, intra sector, for energy performance assessment and energy management	Energy management programmes • Global energy and energy balance • Process integration , Pinch analysis • Off-line and on-line optimisations, at production unit level or plant level • Modular and process intensification concepts for production tools
Deployment of advanced energy-efficient technologies	Incremental improvement of existing technologies via R&D and pilots	
Cogeneration : Combined Heat and Power (CHP)	Development of new heat recovery systems at low, medium and high temperatures	
Heat recovery, pressure recovery	Advanced and breakthrough energy-efficient technologies via demonstrators.	Energy-efficient technologies • Combined Heat and Power with possible use of high & medium T° waste heat • Low and medium T° heat recovery, e.g. Organic Rankin Cycle, water cooling • Efficient combustion, e.g. oxy-burners, recuperative and regenerative burners • Integration of renewable and new energy sources: biomass, geothermal, solar thermal, photovoltaics, wind and biofuels
Energy management tools: energy balance, diagnosis, optimisation	Integration of new renewable energy and new energy sources	
Integration of renewable energy within the process industries	Process intensification	
Adoption of recycled materials where they are able to demonstrate lower energy intensity as compared with materials from virgin primary sources		Industrial synergies between sectors located in the same area • Energy flows • Waste heat recover • Energy transformation, energy transport and temporary energy storage

4.2.1 Energy Efficiency

Industry accounts for more than a quarter of all the energy used in Europe[4], where the process industries represent the major part. Even if these process industries have made major efforts to improve their energy efficiency over the past years[3], there are still levers to achieve additional energy savings, with a time horizon of 2020 across all these process industries producing materials.

Deployment of existing key technologies:
Various levels of advanced technology development and implementation exist in industry, not all the European operators are best-in-class and thus potential to save energy is available, by bringing them up to the level of the best performers through dissemination of best practices and most effective technology (MET). With the financial crisis of the last three years, there are also obstacles to investment in energy-efficient technologies where it seems necessary to develop appropriate incentives. Last, but not least, there are opportunities to leverage existing efficient technologies from one sector to another one.

Sectoral approach for research and innovation in energy efficiency
Within each sector producing materials there are stakes to propose a collective R&I approach gathering all the actors and companies. Equipment suppliers and final clients (manufacturing industry and beyond) have to be associated as well.

Cross-sectoral approach for research and innovation in energy efficiency
In addition to what could be developed within each sector, we are convinced there is huge potential to promote a cross-sectoral approach of R&I through the different industries, in order to identify new ideas, the possible transposition of a new technology from one sector to another one, and to reach the critical mass of means for advanced and breakthrough technologies.

Table 3: Research and Innovation Example Topics – Resource Efficiency

Resource Efficiency		
Development of existing key technologies	Sectoral approach for research and innovation in resource efficiency	Cross-sectoral approach for research and innovation in resource efficiency
Benchmarking, best practices exchanges for Reduce, Reuse, Recycle	Incremental improvement of existing technologies, via R&D, and pilots	Waste and by-products valorisation • Pilot and demonstrators for cross-sectors waste valorisation • Use of waste/by-products from one industry as raw material for another one • Gas separation techniques (gas enrichment, chemical use of waste gases) • Bio- and CO_2-based feedstocks
Deployment of advanced efficient technologies (e.g. for recycling and reuse)	Pilot and demonstrators for intra-sectors waste	
Bio-based feedstocks	Valorisation (Reuse, Recycle)	
	'Cradle-to-cradle' approach	
Water management	Raw materials improvement (selection, preparation, value-in-use concept)	Modular and process intensification concepts for production tools
Waste and by-products valorisation	Bio- and CO_2-based feedstocks	Optimisation of the choice of materials in the production processes
	Yield improvement in the production flow	Societal value of materials on the whole supply chain • Societal approach of materials • Life Cycle Impact (LCC/LCA) • Cradle to cradle approach and second life value chain
	Lean production: shorter lead time, coupling of steps of production, inventory reduction, supply-chain simplification, just-in-time deliveries...	
	Whole supply-chain integration (process industries + manufacturing)	
	Eco-products, eco-design	Industrial water management • Overall water management (cascade use) • Water treatment and water reuse
		Industrial synergies between sectors located in the same area • Industrial symbiosis • Material flows • Logistic synergies for materials

4.2.2 Other Resource Efficiencies

Process Industry producing materials are the main consumers of non-energy raw materials. Raw materials include metallic ores and industrial minerals which may be used in the process industries directly due to their chemical/physical properties. Resource efficiency covers also industrial water, wastes, by-products, and the approaches explored by economists and industrial ecologists related to the 3Rs, for Reduce, Reuse, Recycle.

Deployment of existing key technologies:
Various levels of advanced technology development and implementation exist in industry, not all the European operators are best-in-class and thus potential to save resources is present. This requires bringing all up to the level of the best performers through dissemination of best practices and most effective technology; including optimisation for industrial water management, process yields, zero waste concepts, recycling and reuse.

Sectoral approach for research and innovation in resource efficiency
Within each sector producing materials there are also stakes to propose a collective R&I approach of resource efficiency gathering all the actors and companies. Equipment suppliers and final clients (discrete manufacturing industry and beyond) have to be associated as well. For resource efficiency a global approach along the value chain is key for identifying the 3R potential, Reduce, Reuse and Recycle.

Cross-sectoral approach for research and innovation in resource efficiency
A cross-sectoral approach of R&I through the different industries, is necessary in order to identify new ideas and breakthroughs for resource efficiency. The whole potential of the 3Rs (Reduce, Reuse, Recycle) has to be investigated through a cross-sectoral approach as well. It is the same for the Life Cycle Assessment (LCA) of materials and the cradle to cradle approach, taking into account the whole value chain and cross-sectoral dimension. Some items are already investigated through the new European Innovation Partnerships (EIP) such as Water Efficient Europe and Raw materials. But we think there is clear benefit to gather the process industries for these 2 items.

5. Governance

The SPIRE PPP covering Sustainable Technology by the Process Industry will involve a great number of stake holders from different process industry sectors (already joined in the Resource and Energy Efficiency Partnership), from different value chains – up/downstream as well as from academic and public background.

It is thus required that a well-thought out structure is put in place to govern the PPP and that this structure is formally approved by the stakeholders. The partners collected in REP consider the governance models developed for the European Economic Recovery Plan PPPs; 'Factories of the Future'[11] and 'Energy-Efficient Buildings'[12], as examples from which to develop a structure that fits the stakeholder needs in the PPP.

Thus a specific legal entity could be formed that will function as a counterpart for the European Commission, to manage the process of dynamic roadmap monitoring, annual work programme development setting, as well as managing Key Performance Indicators. This proposal could be concretised in a Memorandum of Understanding that involves all relevant stakeholders, to be set up in the second half of 2011.

6. In Conclusion

The proposal for a Public-Private Partnership on Sustainable Process Industry, as defined by the Resource and Energy Efficiency Partnership, has the potential to make a significant contribution towards a more competitive and eco-efficient economy. The process industry is uniquely positioned to drive this initiative as it converts raw materials to intermediate and end-user products and thus sits at the core of many value chains. Some of the benefits associated with this proposal are:

- It addresses the grand societal challenges as defined within the EU 2020 strategy.
- It will create new markets with large opportunities for Europe to be a world leader, create jobs and economic value.
- It is built on the collective expertise of more than 10 major industry sectors as united within REP, all with strong connections to process manufacturing.
  The proposal can count on the engagement of REP in the further definition of a PPP work package structure, multi-year roadmap and consortium structure.
- The stakeholders in the SPIRE PPP will include public, research and technology organisations and academia, as well as industry participants along the value chain at both European and national level.
- The PPP will bring the benefit of a multi-year, strategic and dynamic roadmap that will enable the immediate and urgent needs associated with an eco-efficient economy to be addressed, as well as a longer term vision. It will provide for strategic overview that allows planning research, development and innovation activities as well as addressing policy and regulatory matters.
- The value chain approach and the active role of industry in definition of the PPP proposal ensures that real and urgent needs will be addressed first as a priority, and that there is commitment in effective execution of the PPP.
- This value chain approach and the active industry role will also facilitate a fast uptake of the results of the PPP in the market. The solutions will be developed with a practical implementation focus, close to market and able to benefit from the industry's leverage.
- The many sectors grouped within REP provide great opportunity for cross-sectoral synergies including: leverage of solutions across sectors, definition of solutions that require support across sectors, and the establishment of the basis for implementation across sectors.

References

1 *United Nations, 1987, Report of the World Commission on Environment and Development, General Assembly Resolution 42/187, 11 December 1987*

2 *COM(2010) 614, An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage, p30*

3 *Ecorys for: European Commission - DG Enterprise and Industry, February 2011, Study on the competitiveness of European Companies and Resource Efficiency*

4 *http://www.europarl.europa.eu/oeil/resume.jsp?id=5914242&eventId=1159601&backToCaller=NO&language=en*

5 *Eurostat, http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/*

6 *Agarwal, A. and Strachan, P. 2008, Is Industrial Symbiosis only a Concept for Developed Countries?, The Journal for Waste & Resource Management Professionals, The Chartered Institution of Wastes Management, p42*

7 *Reference data based on Eurostat, 'current level' is the period 2008-2011*

8 *http://www.europarl.europa.eu/oeil/resume.jsp?id=5914242&eventId=1159601&backToCaller=NO&language=en*

9 *George S. Ford, Ph.D.; Thomas M. Koutsky, Esq.; Lawrence J. Spiwak, Esq., Phoenix Center, September 2007, A Valley of Death in the Innovation Sequence: an Economic Investigation*

10 *European Commission - DG ENV, Cowi a/s, May 2009, Bridging the Valley of Death: public support for commercialisation of eco-innovation*

11 *http://www.effra.eu/*

12 *http://www.eeba.org/*

Appendix

Recommendations to the European Union and Member States for Rapid and Efficient Implementation of Innovation in Industry.

Appropriate Framework Conditions and Legislation

Access to finance

Manufacturers have specific financing needs for capital investment but also for credit lines and cash flow:

- Create conditions for easier access to financing across the supply chain, with products addressing the needs of SMEs as well as large enterprises.

Industry depends on major capital investment with pay-back periods of 5 years or above:

- Develop financial solutions suited to longer pay-back periods, and improve investor knowledge about technology and performance.

Companies need financing for global activities:

- Improve funding from international financing sources (EIB, EBRD) and third parties (banks, equity financing companies).

National export finance schemes are restrictive for global players:

- Improve coordination of national export finance schemes.

Global eco-conception approach and demonstration projects

Sustainability targets and increasingly the market itself are demanding new environmentally friendly process technologies using a global eco-conception approach:

- Develop industrial demonstration projects to showcase competitive manufacturing processes in Europe and promote the concept of industrial ecology, via closer collaboration with industry.

New approaches and innovations are harder to deploy in markets characterised by more refurbishment than new-build (Europe):

- Promote awareness and acceptance of technologies; disseminate knowledge about performance and efficiency of technologies.

The European research programmes produce high-quality research, but commercial exploitation is weak.

Employment, skills development and mobility

Industry is vital for generating new employment:

- Strengthen the role of industry in the European Recovery Plan.

Manufacturers represent a potent source of employment but industry fails to attract school leavers, apprentices and graduates:

- Co-ordinate actors in the supply chain, employee and employer organisations as well as stakeholders to reduce the gap between skills available and market needs, including specialisation in energy and resource efficiency.

Standards of equipment, including their maintenance, have a crucial bearing on energy and resource usage and environmental performance:

- Promote high standards of operational maintenance skills, and disseminate this across specialist sectors.

Deployment of key technologies

Good technological solutions are available, but deployment can be slow due to lack of awareness and financial solutions (see 1.1):

- Quicker information dissemination and communications are needed in order to deploy best available technologies in industry.
- Adopt an intelligent understanding of manufacturing, looking beyond glossy views and avoiding artificial discrimination between "green" and other human or industrial activities, advanced versus traditional, etc.
- Provide equivalent effort for energy-intensive industry, where the potential gains in terms of environmental impact, employment, and competitiveness are much higher.

Certain EU initiatives are poorly co-ordinated and create artificial divisions between technology areas (e.g. ICT and other industries):

- Improve exchange between industry sectors to improve knowledge and exploit synergies between industry sectors, for example through a high-level expert group composed of Members States' industrial participants, technology platforms, joint technology initiatives and academic experts.

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