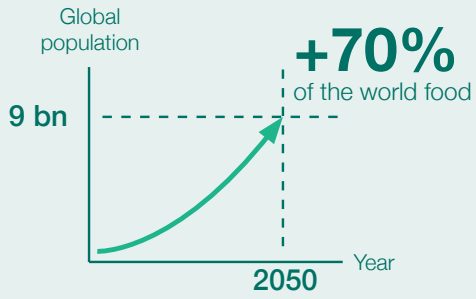
FOCUS ON **BIOECONOMY**

Sustainable bioeconomy: A SusChem innovation priority.

Over the coming decades, the world will witness increased competition for limited and finite natural resources.



The European Commission sees the bioeconomy[1] as Europe's response to the key environmental challenges that the world is facing today. Promoting the bioeconomy will help to reduce Europe's dependence on natural resources, transform manufacturing, promote sustainable production of renewable resources and encourage their conversion into food, feed, fibre, biobased products and bioenergy, while growing new jobs and industries.

A transition will be needed towards an optimal use of renewable biological resources. We must move towards sustainable primary production and processing systems that can produce more food, fibre and other biobased products with fewer inputs, less environmental impact and reduced greenhouse gas emissions.

Managed in a sustainable manner, the bioeconomy can help build a more competitive, innovative and prosperous Europe by:

- sustaining a wide range of public goods, including biodiversity and ecosystem services,
- reducing the environmental footprint of primary production and the supply chain as a whole,
- increasing competitiveness,
- enhancing Europe's self-reliance, and
- providing jobs and business opportunities.

SUSCHEM AND THE BIOECONOMY

A sustainable bioeconomy features in the SusChem Strategic Innovation and Research Agenda (SIRA) encompassing the production of renewable biological resources and the conversion of these resources and associated waste streams into value-added products such as feed, food, biobased products and bioenergy.

Integrated biorefineries are central to the development of the bioeconomy and were one SusChem's original flagship innovation concepts. They can deliver new sources of chemical building blocks that are either structurally similar to fossil-based feedstock or new with novel functionalities and improved properties. In order to unlock the full potential of a sustainable biomass supply, it is essential to consider all possible sources including second generation biomass and waste streams (such as municipal wastes). The bioeconomy can improve resource efficiency and is a key element in achieving the broader concept of a circular, integrated, renewable economy.

Innovation is also a key solution provider for the transition to a more Circular Economy and the development by the chemical sector of innovative advanced materials and process technologies is essential to enable a better use of existing resources along the whole life cycle, to develop new production and recycling paths.

SUSCHEM – AN ESSENTIAL LINK

SusChem is an essential link between the chemical industry, industrial biotechnology and stakeholders in the bioeconomy and is actively involved in two large and relevant PPPs between the European Commission and industry that were launched in 2014: the 'Biobased Industries' (BBI) Joint Undertaking that brings together research and industry partners along the whole value chain of biobased products and focuses on innovation for products from biobased feedstock; and the 'Sustainable Process Industry through Resource and Energy Efficiency'[2] (SPIRE) PPP that provides a solid basis for academia, SMEs, and multinational companies to collaborate on cross-sectorial initiatives in these areas.

SusChem contributes to the alignment of both initiatives and recently participated in the successful BBI Info Day.

The interface between BBI and SPIRE is the provision and use of biobased platform chemicals. In addition, both PPPs may support projects using biotechnological conversion processes and specific improvements of biotechnology processes may be eligible for funding through either PPP. SusChem is working to ensure the coherence of on-going and future funding initiatives and the deployment of flagship projects that demonstrate technological leadership and that Europe is a globally competitive location to invest in the bioeconomy.

[1] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/bioeconomy
[2] http://www.spire2030.eu/

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FOCUS ON **CIRCULAR ECONOMY**

Circular Economy: A SusChem policy priority.

SusChem's position paper on the circular economy develops its vision for a functioning circular economy in Europe (and globally) and provides some concrete examples of the high impact contributions that the platform and its partners can make to achieve this essential objective.

THE SUSCHEM POSITION

SusChem's position paper has **three main messages**:

1. A SUSTAINABILITY-BASED APPROACH IS NEEDED

The integration of all aspects of sustainability over the whole product life-cycle is essential to the development of a circular economy in order to effectively ensure a positive impact on society while optimising environmental impact and maintaining economic growth.

2. TECHNOLOGY DEVELOPMENT IS REQUIRED FOR A SUSTAINABLE CIRCULAR ECONOMY

A circular economy cannot be achieved only through implementation of new regulations, services and business models. Advanced technologies are essential to enable a better use of existing resources along the whole life cycle to develop new production and recycling paths – and the expertise of the chemical industry as a material supplier is highly valuable and important here.

In particular SusChem believes that the principle technology developments should take place in the following three areas:

- **Utilisation of sustainable alternative feedstock** including secondary raw materials, ligno-cellulosic biomass, waste or industrial gas effluents (including CO_2).
- **Design of sustainable materials enabling eco design of 'products'** that are easy to recycle while maintaining or improving performance.
- **Improved efficiency for production processes** to maximise the use of all resources entering the system including primary and secondary raw materials, water, and energy.

These technologies are more fully described in the SusChem 2015 Strategic Innovation and Research Agenda (SIRA) and should be supported through the appropriate European funding instruments.

3. COHERENCE AND STABILITY OVER TIME FOR THE POLICY FRAMEWORK IS CRITICAL FOR EUROPEAN LEADERSHIP

To contribute fully to a sustainable economy, **the circular economy policy should be developed in coordination with other related policies** such as the Energy Union Package. Policy coherence, as well as policy stability over time, is essential to **establish a regulatory framework that enables investment** in sustainable, resource efficient and innovative technologies in Europe and ensures European leadership in sustainable/clean technologies.

The position paper concludes with five examples that describe a selection of potential contributions by SusChem technology solutions to the circular economy: the use of CO_2 as an alternative carbon resource; new composite materials; new catalysts; industrial symbiosis and biorefineries.

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FOCUS ON **ENERGY UNION**

Energy Union: A SusChem policy priority.

The chemical industry needs energy in its processes and has a strong track record in reducing energy consumption through innovation and manufacturing excellence.

SUSTAINABLE CHEMISTRY SOLUTIONS

Examples of innovations that will contribute to further improving energy and resource efficiency in the chemical sector include:

- **Increased energy efficiency of process technologies** through advanced high performance catalysis, process intensification, and advanced process modelling and control.
- **Better utilisation of alternative sources of carbon** such as biomass, waste, and industrial gaseous effluents (including CO_2).
- **Industrial symbiosis** making connections with and across industries for improved energy and resource efficiency via better valorisation of heat, improved water management and use of materials from waste and side streams.

Equally important are the solutions provided by the chemical industry to the development of a low carbon economy and energy efficiency in other sectors.

The chemical industry is a key solution provider in virtually all value chains, with technologies and advanced materials that enable Europe to be a world leader in renewable energy such as:

- **Advanced materials for sustainable production of renewable electricity** including new composites for wind turbine blades and materials for photovoltaic technologies including recyclability of materials.
- **Advanced materials and technologies for renewable energy storage** including materials for advanced batteries, chemical energy storage through advanced materials and process technologies (hydrogen and CO_2 based energy carriers via power-to-gas and power-to-liquid technologies), and novel thermal storage of energy via phase change materials or via reversible thermochemical reaction.
- In addition sustainable chemistry provides **energy efficiency solutions for buildings** such as advanced materials for thermal insulation, highly energy efficient lighting, and phase change materials for thermal storage. Chemistry is also key to better energy efficiency in water treatment, for example by development of advanced membranes for water purification.
- Chemistry is also key to more **sustainable transport systems** by providing lightweight materials, materials for more fuel efficient tyres, advanced materials and process technologies for battery production and sustainable alternative fuels for transport including CO_2 based fuels such as methanol, methane, gasoline and kerosene.

In fact, since 1990, the chemical sector has effectively decoupled production from greenhouse gas (GHG) emissions.

The European Commission's Energy Union strategy, adopted in February 2015, dedicates one of its five dimensions to research, innovation and competitiveness. The integrated Strategic Energy Technology (SET) Plan plays a central role in a new European energy Research and Innovation approach designed to accelerate the transformation of our energy system.

Advances in sustainable chemistry are key elements in achieving the objectives of the European Commission's Energy Union and SET-Plan. SusChem's Strategic Innovation and Research Agenda (SIRA) dedicates a chapter to the challenge of, and solutions for, Secure, Clean and Efficient Energy. The chapter covers energy efficiency in chemical processes and proposed solutions that are keys to the competitiveness of the chemical industry. It also describes how the industry's technologies and products contribute to energy efficiency and clean energy productions and storage for the wider society.

HOW TO SUSTAIN SUCCESS?

In order for the chemical industry to make an effective impact on the development of a low carbon economy, support for technology development (including achieving breakthroughs) and an appropriate policy framework (to ensure market uptake) will be required.

A sustainability based approach for policy development involving the integration of all aspects of sustainability (environment, economy, social) and integration of lifecycle concept is essential to evaluate the impact of innovative technologies and the development of an effective strategy and policy framework.

Coherence and stability over time for the policy framework is critical to contribute fully to a sustainable economy and address climate goals. This means that a variety of policies have to be developed in coordination such as those on energy, primary and secondary resources.

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FOCUS ON **INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)**

ICT for Process: A SusChem innovation priority.

The recent European Commission communication on 'Digitising European Industry – Reaping the full benefits of a Digital Single Market' highlighted the role of the SusChem supported PPPs - Sustainable Process Industry through Resource and energy Efficiency (SPIRE) and Bio-Based Industries (BBI) - to help industry seize the new opportunities offered by ICT enabled innovation. On 10 March SusChem organised a workshop involving around 20 ICT experts from companies and academia to discuss 'Digitisation' on the European level and to build the base for future funding calls, projects and collaborations.

SUSCHEM, PROCESS ICT AND #DigitiseEU

From new forms of production to innovative business models the process industry is about to experience a revolution enabled by digital technologies. Digitisation is expected to have a high impact on modernising Europe's production capabilities and can boost European process industries in the race for global competitiveness and sustainability.

The European chemical industry is a strong contributor to the roots of the European economy. Digitisation is already present in all aspects of the sector's activities as it is essential from logistics, product and process design, planning, plant operations and plant safety to marketing/sales and customer integration.

In addition, smart materials developed by the chemical industry enable new and higher performing ICT developments in printable-, wearable-, nano-electronics or 3D printing techniques and also allow more sustainable manufacture of new electronic devices avoiding material losses and waste generation.

To remain competitive, future factories will need well-integrated ICT systems as production increasingly uses digital innovations such as data capture, planning and control, modelling and simulation, cloud computing and big data analysis enabled by high performance computers and data connections. Data analytics will allow enterprises to convert data into knowledge, and effectively contribute to more efficient and safer processes with less environmental impact by more efficient management of resources, water and energy.

ICT AND MANUFACTURING

With a focus on the manufacturing environment, important categories for further development for the chemical industry include:

- **Modelling, Simulation and Forecasting:** Integration of modelling of single processes into production routes with modelling extended to all levels of automation, including scheduling and management systems as well as on-line decision making processes.
- **Real Time Data Availability:** Development of hard- and soft-sensors for continuous processes that are reliable, fast, accurate and contact-less for use in intelligent self-optimising measurement systems along the whole production route and fully integrated in the plant automation environment.
- **Transformation of 'Big Data' into Lean Information:** Identifying universal solutions for handling large amounts of data, methods to improve their reliability, techniques to assign them to product performance and explaining their practical meaning to all relevant applications.
- **Intelligent Self-learning Systems:** Building models based on data and results, which continue to learn and broaden the scope of the models, based on closed loop performance monitoring.
- **Condition Based Advanced Maintenance:** Developing tools and methods based on models, sensors, diagnosis and data analysis to allow remote control of equipment, prediction and prevention of failures, identification of trends and avoidance of efficiency losses and unwanted stoppages.
- **Product Quality Monitoring:** Implementing integrated quality control factory-wide systems to monitor the evolution of quality across the production route by calling on information technology to better link process operations and plant logistics to give production flexibility.
- **Resource and Energy/ Lifecycle analysis (LCA):** Enabling monitoring of environmental targets (energy / water use, CO2-emissions etc.) in all control systems as an additional set of constraints to optimise the overall sustainable performance.
- **Data Privacy:** Developing advanced security solutions to prevent misuse of stored data and protect plant control systems or cloud-stored data from malicious attack.
- **Human-Machine Interface:** Developing intuitive and user friendly interfaces for (plant)-managers, operators etc., information and their interpretation have to be available at all times in all locations.

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FOCUS ON **MATERIALS**

Materials:
A SusChem innovation priority.

There are at least two European Commission policy areas that relate closely to materials. One is 'Closing the loop - An EU action plan for the Circular Economy' and the second is the Energy Union with its Strategic Energy Technology (SET) plan. SusChem has defined its priority areas for research and innovation in materials as materials for energy efficiency, materials for low carbon electricity production, and materials for energy storage.

However, these three application areas remain very wide and SusChem wants to narrow down the priorities in order to maximise impact. Therefore SusChem is looking to engage its stakeholders to support and contribute to refining and defining the top priorities for sustainable chemistry in the materials domain.

MATERIALS AND ENERGY

The chemical industry is a key solution provider for many value chains and other industry sectors that are aligned with the priorities outlines in the fifth pillar (research and innovation) of the Energy Union.

Sustainable chemistry provides technologies and advanced materials for:

- **Enabling the EU to be a world leader in renewable energy**. This includes providing advanced materials
- **For sustainable production of renewable electricity**, for example new composites for wind turbine blades and materials for photovoltaic technologies that include the recycling of these materials,
- **For energy storage**, for example: electrical energy storage - materials for advanced batteries; chemical energy storage - advanced materials and process technologies such as H_2 and CO_2 based energy carriers via power-to-gas and power-to-liquid technologies; and thermal energy storage - phase change materials or reversible thermochemical reactions.
- **Efficient energy conservation solutions** to make the future and existing building stock energy neutral. This includes: advanced materials for thermal insulation, efficient lighting, and phase change materials amongst others.
- **More sustainable transport systems** through the use of lightweight materials as a solution to enable lower carbon transport. This includes innovation in 'light-weighting' technologies in terms of both materials and process technologies that can play a vital role to improve fuel efficiency and reduce CO_2 emissions in transport. Composite materials, such as fibre reinforced plastics (FRP that can be carbon or glass reinforced) have a significant potential for weight reduction in vehicles. They can offer light weight benefits in comparison to other structural metallic materials, while maintaining high mechanical properties. In addition hybrid materials, combining composites and metals, with appropriate joining technologies, can reduce vehicle weight. Materials development for more fuel efficient tyres and advanced battery technologies are also important.

MATERIALS AND THE CIRCULAR ECONOMY

The development of innovative advanced materials by the chemical sector is essential to enable a better use of existing resources along the whole life cycle of products and services, and to develop new production and recycling process paths.

The development of materials enabling 'eco-design' of products is required to address very demanding requirements in terms of performance in downstream applications, including better recyclability. New technological development of materials is often carried out by the chemical industry in collaboration with its value chain partners to provide improved / desired material characteristics and to enable more recyclable end-use products.

For this design and development process to be effective, sustainability assessment over the whole life cycle of the product needs to be considered. The evaluation of environmental impact should consider all environmental aspects including energy and water.

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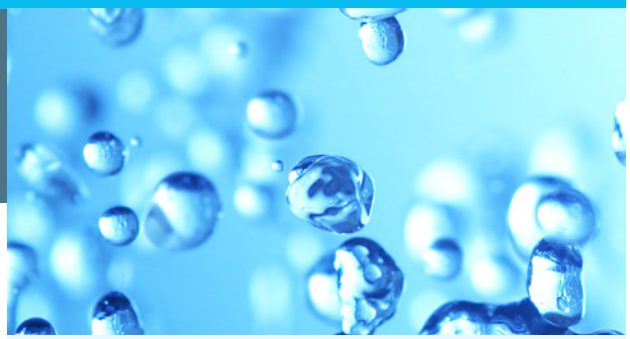
FOCUS ON
SUSTAINABLE WATER SOLUTIONS

Water:
A SusChem innovation priority.



WATER AND SUSTAINABLE CHEMISTRY

Water is a scarce resource and a critical element for the development of our society and economy. The continuing increase in urbanisation and agricultural production combined with new demands from the development of biobased and eco-industries and the need to preserve biodiversity and the natural ecosystem put high demands on water management. The chemical industry is a user of water but it is also an important solution provider of innovative products, technologies and services which can enable more sustainable water management. On this front, SusChem and the chemical industry are very active in the European Innovation Partnership Water (Water EIP).

Water is used in the chemical industry for many purposes including processing, washing, diluting and heating, cooling, and transporting product. The chemical industry aims at near-zero discharge of water by using closed-loop systems.

The control of impurities in closed water systems needs a combination of real time monitoring tools and sensors, highly selective separation processes and new water treatments to prevent fouling and corrosion.

Water efficiency measures are also aligned with targets to reduce energy consumption: energy consumption is a critical indicator when developing new technologies for water management and water treatment. Water symbiosis and delivery of 'fit-for-purpose' water are considered as key elements to ensure and enable the optimal and integrated (re)use of water not only for the chemical industry but also in collaboration with other sectors including urban and agricultural use.

FOCUS ON WATER INNOVATION

SusChem's working group on water complete its efforts in formulating recommendations, but broad areas of water innovation programmes already identified important sources of water including desalination, re-use of treated wastewater, rainwater harvesting and gas humidity condensation (such as cooling tower blowdown). Different technical options are in development to access these sources with their specific implementation strongly dependent on local conditions. Development of 'tailor-made' system solutions and scale up testing for robust industrial processes will be required.

Water treatment, reuse & resource recovery, and cross industry symbioses. 'Fit for Purpose' will become the driving force in water treatment and management. Developments required for full scale implementation of this new paradigm include:

- Development of new chemical additives for water treatment to facilitate reuse.
- Economically effective solutions to remove and recover salts from industry water.
- Development of advanced membrane technologies to increase selectivity, reduce energy use and reduce maintenance operations (fouling resistance).
- Resource recovery ("circular economy"), development of novel highly selective and energy-efficient separation technologies to recover specific resources (e.g. phosphorous) from industry wastewater.
- Water analysis including online analysis & process development.
- Water distribution, in particular loss of water in distribution networks.

The European Commission's action plan for 'Closing the loop - An EU action plan for the Circular Economy' translates literally to the realm of the chemical industry and its customers. Development of technologies enabling closing of water loops are highlighted in the two SusChem inspired European PPPs - Sustainable Process Industry through Resource and energy Efficiency (SPIRE) and Bio-Based Industries (BBI) – and are working to enable industry to seize the opportunities offered by water innovation programmes.

In the spring of 2016, SusChem set up a working group of water experts from industry to identify and develop the SusChem 'Water Innovation Agenda' at a European level and to build the base for future funding calls, projects and collaborations.

E4WATER SHOWS THE WAY

A recently completed SusChem inspired and EU funded project E4Water has shown what is possible in the chemical and related sectors in terms of water management. At the project's final conference in April 2016, The project illustrated the ability to de-couple the growing economic activity of the chemical industry from actual water use.

WATER INNOVATION POTENTIAL

SusChem inspired initiatives such as SPIRE are helping to make sustainable water use in a wide cross-section of European industries a reality. Close cooperation and alignment in the definition phases of the funding calls available under Horizon 2020 across all PPPs and all levels of stakeholder involvement is necessary to ensure that all the needs of the process industries are fully considered.

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