SUSCHEM
European Technology Platform
for Sustainable Chemistry

Research & Innovation priorities in Sustainable Chemistry

SusChem ETP

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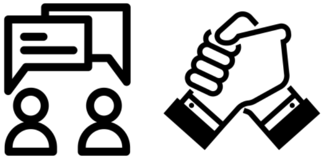
Asamblea General SusChem – España
‘Química y la Energía’ – 07.10.2020

1. SusChem ETP & the National Technology Platforms (NTPs)

SusChem ETP – a European Technology Platform

SusChem ETP focus: Sustainable Chemistry and Industrial Biotechnology



1. Open multi-stakeholders forum

- Mobilizing and bringing together stakeholders from the **large Industry, SMEs,** *startups*, and **Academia (Universities & RTOs)**
- Promote knowledge transfer across the EU

2. Advisory instrument (technology priorities)

- Tech 'radar': Driving innovation, defining **priorities/ solutions** to **global challenges** and **EU priorities**
- **RD&I agendas** to be supported by both private and public funding (EU and national level)

Founding members& SusChem Board

Founded in 2004
6 founding members: Cefic, DECHEMA, RSC, EuropaBio, ESAB, GDCh

SusChem Board*

**Additional links w DG-Grow and DG-RTD (EC)*

SusChem NTPs network
A network across Europe - Bridging National and EU priorities

- 17 SusChem NTPs (National Technology Platforms)
- **SusChem ES: long-standing and high-value stakeholder**

*** links, especially with SMEs and Academia at national level*
**** National Contact Points (NCPs)*

SusChem& the contribution to Sustainable Chemistry

Holistic view:
Sustainable Chemistry & Industrial Biotech
--- SusChem pillars ---

Digital Technologies

Advanced Processes

Advanced Materials

Horizontal topics
(e.g. sustainability assessment, Edu/skills)

Innovation Ecosystem – Sustainable Chemistry

- Technology-focused working groups (white papers)
- SIRA development (advisory role on technology priorities/ EU priorities)
- EC consultations – relevant to innovation and funding in Sustainable Chemistry
- Visionary projects (e.g. F^3 factory)
- Brokerage events (EU projects consortia, fostering collaborative initiatives)
- Stakeholder events (public consultation & connecting stakeholders)

With input from the NTPs on all the above

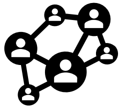
2. SusChem SIRA towards 2030:

Reviewing RD& I priorities for the chemical sector

Launching the current SusChem SIRA (towards 2030)

Publication link

SIRA: a multi-stakeholders collaboration effort




- \> 100 experts/ SusChem stakeholders
- Academia, RTOs, SMEs, associations, large industry
- SusChem Board
- **<u>SusChem NTPs</u>**
- Core project team (Cefic)

< SusChem overarching & interconnected priorities >

Technologies for a better Future of Europe

CIRCULAR ECONOMY AND RESOURCE EFFICIENCY

Transforming Europe into a more circular economy

LOW CARBON ECONOMY

Mitigating climate change, with Europe becoming carbon neutral

ENVIRONMENTAL AND HUMAN HEALTH

Europe leading on environmental and human health protection

(*Strong links with energy efficiency)

New SusChem SIRA – core structure / R& I priorities

‘Innovation priorities for EU and Global challenges’

Advanced Materials

Advanced Processes

Enabling Digital Technologies

Multi-KETs*

*KETs: Key Enabling Technologies

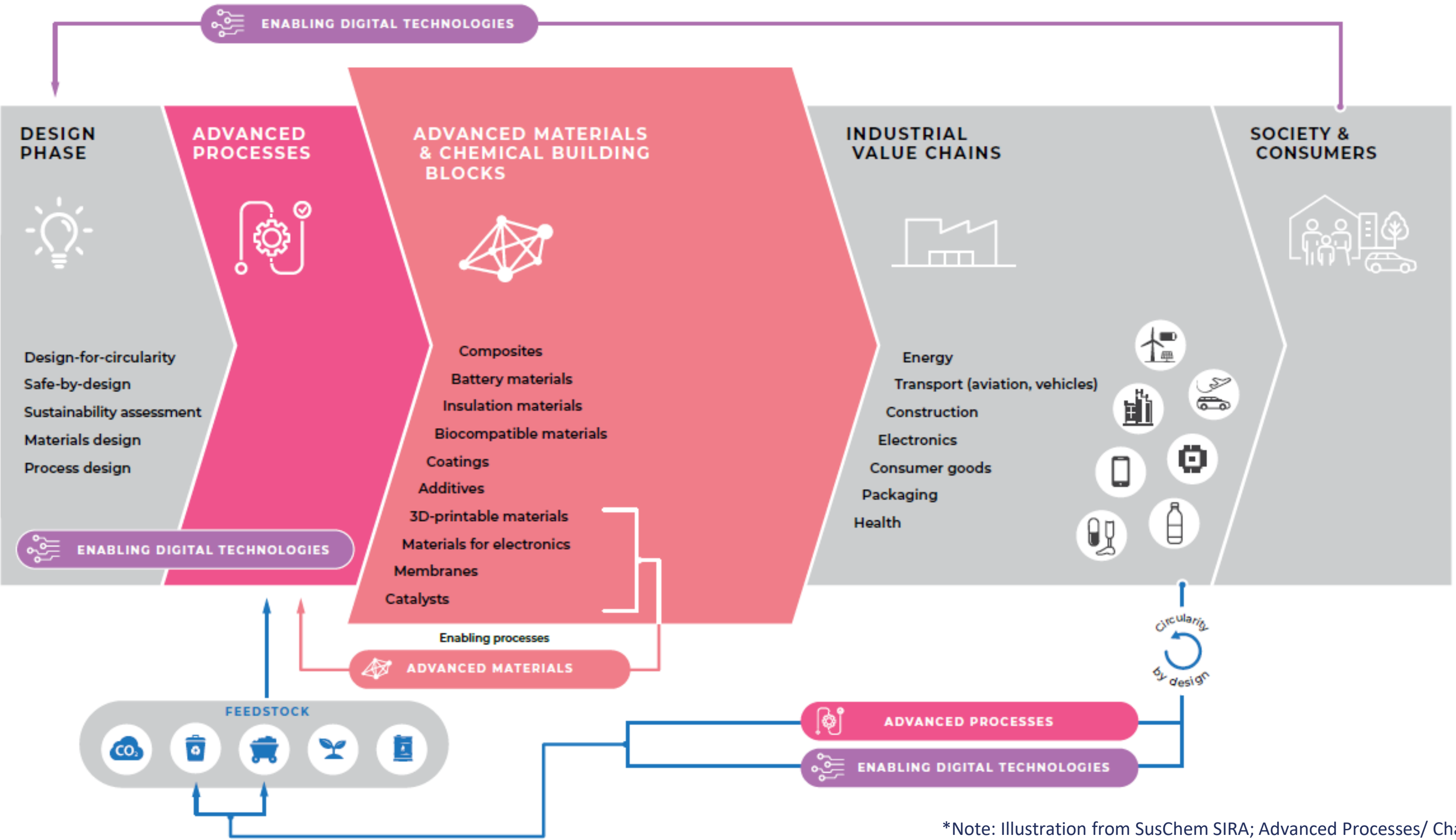
SUSTAINABILITY ASSESSMENT INNOVATION
EDUCATION AND SKILLS CAPACITY
ENABLING DIGITAL TECHNOLOGIES

Horizon Europe

SUSTAINABLE DEVELOPMENT GOALS

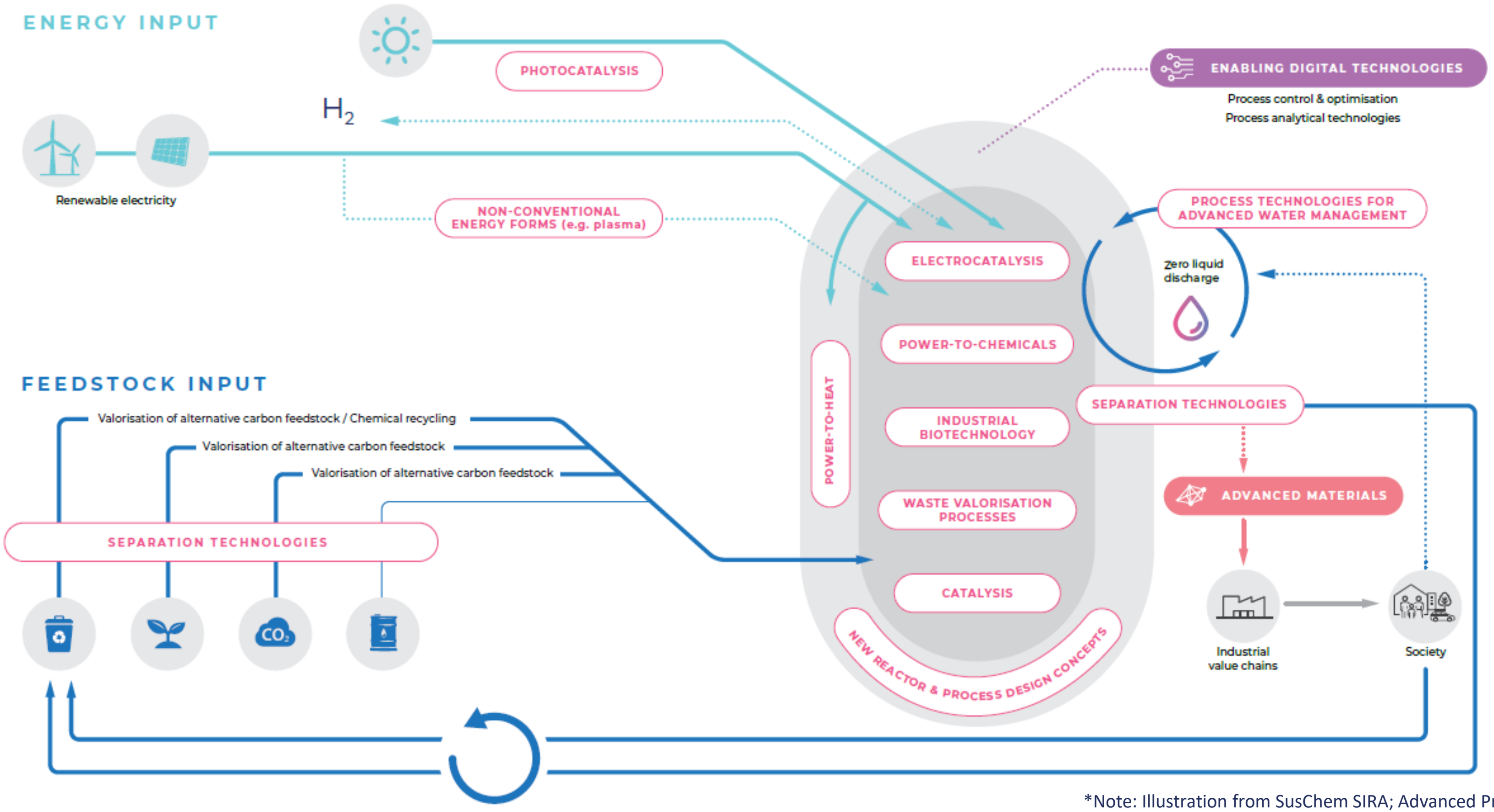
Impact on:
-UN SDGs &
-Horizon Europe (2021-2017)

Advanced materials as solutions for other industrial value chains



*Note: Illustration from SusChem SIRA; Advanced Processes/ Chapter 2

Advanced Processes
for energy transition & circular economy



*Note: Illustration from SusChem SIRA; Advanced Processes/ Chapter 3

Digitalisation Transforms the Chemical Industry Rapidly Across its Entire Value Chain

ADVANCED MATERIALS

ADVANCED PROCESSES

ADVANCED PROCESSES

ADVANCED MATERIALS

Management of feedstock supply

Big data-driven raw material analytics to optimize feedstock costs, flexibilisation in feedstock (including waste, biomass and CO_2)

R&D/ Laboratory 4.0

Machine-learning and artificial intelligence-driven research, advanced materials and formulation simulation, digital process development, digital twins, laboratory automation and high throughput screening

Cognitive plants

PAT-based real-time model predictive control and process optimisation based on physical properties models enhanced by advanced data analytics/AI

Predictive maintenance

Advanced analytics-based predictive and risk-based asset maintenance

Management of processes

Scheduling of connected processes within plants and sites

Supply chains in a circular economy

Increase transparency through tracking and tracing of products throughout life-cycles, e.g. by blockchain technology

New roads-to-market

Digitalisation of customer experiences, involving customers and/or consumers into the product development cycle, providing additional services, disruptive new business models

Supply chain integration

Production data sharing with suppliers/real-time supply tracking, digital tools enabling more efficient procurement processes

New forms for collaboration & co-creation

Platforms for exchanging R&D data, platforms to collaborate and for data exchange, co-creation within the sector and beyond

Process analytics (PAT)

Advanced sensing and process-analytical technology for tighter closed-loop process monitoring and control, at reasonable cost

ADVANCED PROCESSES

Risk management

Advanced analytics-based cybersecurity management

Industrial symbiosis

Model-based coordination and management of energy and material flows across industries and with municipalities/cities

Operator support

Advanced process interfaces, augmented reality, digital twins for training purposes

SUSCHEM ENABLING DIGITAL TECHNOLOGIES
DIGITAL INNOVATIONS FOR THE CHEMICAL INDUSTRY

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*Note: Illustration from SusChem SIRA; Enabling Digital technologies - Chapter 4

3. Energy efficiency focus

Sustainable Production of Renewable Electricity

Thin film& organic photovoltaics.
(robustness and efficiency)

Materials for wind turbines
(circularity-by-design)

Multi-junction photovoltaic materials.
(performance and efficiency at a larger range of wavelengths)

Laboratory 4.0 – Digital R&D
(materials simulation, laboratory automation and high throughput screening)

TRL > 5 target – demo actions& beyond:

- Enhanced efficiency solutions: existing global thin film PV market & new markets.
- Materials for multi-junction PV cells: high performance, capturing energy in wider ranges of wavelength of the incident light.
- Circularity-by-design strategies* for wind turbine materials (chemical & mechanical recycling) - maintain processing properties, mechanical strength, chemical resistance.* *By 2050, ~40 million tonnes of waste material will become 'available' by the global wind industry.*

Energy efficiency in transport and buildings.

Composites & cellular materials

Materials for energy storage

Laboratory 4.0 – Digital R&D

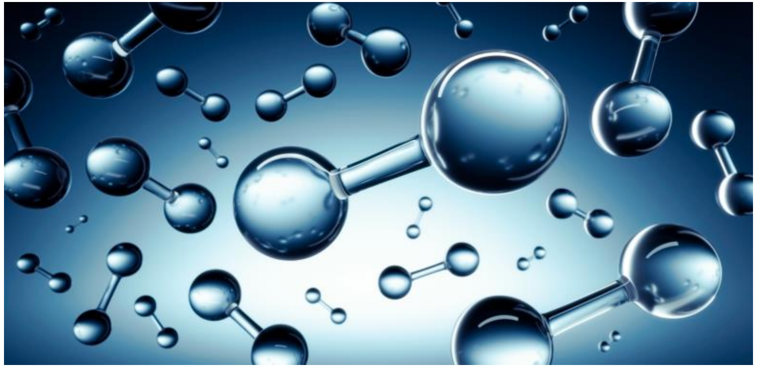
Renewable Energy storage

Materials for energy storage
(lithium-ion batteries, redox flow batteries, metal-air batteries, organic batteries, materials for large capacity thermo-solar and heat energy storage)

Power-to-chemicals
(syngas, methanol, fuels, methane, ammonia)

Hydrogen production w low carbon footprint
(Alkaline water electrolysis (AWE), Polymer Electrolyte Membrane water electrolysis (PEM), Solid Oxide Electrolysis (SOE), Methane pyrolysis, water photolysis.

[Large scale demonstration for the already technologically mature technologies]



- Shift to low- and zero-emission vehicles, incl. electric vehicles. Batteries for clean mobility and energy systems (EU Action plan for batteries).
- H_2 (global production) : 55% ammonia production (fertilizers), 25 % fossil fuels refineries, 10 % methanol production (polymers). Currently the production of H_2 is responsible for 830 million tons of CO_2 /year (global scale).
- Power-to-chemicals to contribute in the introduction of renewable electricity in the chemical industry.

Electrification of chemical processes and use of renewable resources.

Increased Energy efficiency of chemical process technologies. [overarching goal].

- **New reactor& process design concepts**
- **Catalysis [enabling CO_2 valorization via catalysis]**
- **Coordination &management of connected processes**
- **Cognitive plants (real-time process simulation, monitoring, control and optimization)**
- **Power-to-chemicals & Power-to-heat**
- **Hydrogen production with low carbon footprint**

- Tolerant and intensified reactors and processes (feedstock variability & energy fluctuation).
- Electrochemical and photo-electrochemical reactors (including considerations for recovering valuable materials/ e.g. catalysts).
- New reactor and process design utilizing non-conventional energy forms (plasma, ultrasound, microwave, …).

Energy efficient water treatment.

Process Analytical Technologies (PAT)

Advanced (Big-Data) analytics and AI

Coordination &management of connected processes

Cognitive plants (real-time process simulation, monitoring, control and optimization)

Membranes for separation in diluted conditions.

- Water reuse& recycling – ‘zero liquid discharge’
- Alternative water sources and water symbiosis
- Decentralized/smaller treatment systems
- PAT – water operations and treatment. PAT for continuous flow reactors and modular processes
- Water data management (advanced data analytics & AI)

Digital technologies – ‘business level’ contributions

Industrial symbiosis via better valorization of energy streams

Industrial symbiosis - better valorization of energy streams

Supporting decision making

- Key enabling digital technologies: … data sharing platforms& data security, coordination and management of connected processes, advanced (big-) data analytics and AI
- Horizontal topics contribution: advancing on education &skills capacity in Europe, Sustainability assessment innovation

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Thank you.

Contact: vfi@cefic.be or suschem@suschem.org

4. Back-up slides

< Low Carbon Economy>

Focus areas – building on RD& I actions

- **Sustainable production of renewable electricity.**
- **Renewable energy storage.**
- **Energy efficiency in transport and buildings.**
- **Increased Energy efficiency of chemical process technologies. [overarching goal]**
- **Electrification of chemical processes and use of renewable resources.**
- **Energy efficient water treatment.**
- **Industrial symbiosis via better valorization of energy streams.**
- **Alternative Business models (sectors coupling).**
- **Supporting decision making.**

4. ADVANCED MATERIALS – TECHNOLOGY PRIORITIES outline

Enabling functionalities in **novel products** or **enhancements** of **existing products**.

- **new market applications;**
- **new value chains;**
- successful **integration of alternative carbon feedstock;**
- **circular economy transition: circularity-by-design;**
- **synergies** with innovation in advanced processes and digital technologies.

>Composites and cellular materials

>3D-printable materials

>Bio-based chemicals and materials

>Additives

>Biocompatible and smart materials

>Materials for Electronics

>Membranes

>Materials for energy storage

>Coatings and Aerogels

4. ADVANCED PROCESSES – TECHNOLOGY PRIORITIES outline

- Improving: energy and resource efficiency of **existing process technologies**
- **Disruptive process technologies** to:
    - Increase the share of renewable energy,
    - Improve the utilization of alternative carbon sources
- broader contribution to circular economy: recovery and valorization of critical raw materials and water.
- **Crucial synergies with digital technologies.**

>New reactor and process design concepts;
>Modular production;
>Advanced separation process technologies;
>New reactor and process design utilizing non-conventional energy forms;
>Electrochemical, Electrocatalytic and Photo-electrocatalytic Processes;
>Power-to-Heat;
>Hydrogen production with low-carbon footprint;
>Power-to-chemicals;
>Catalysis;
>Advanced Processes: Industrial Biotechnology;
> Waste valorization processes;
> Process technologies for advanced water management;

4. ENABLING DIGITAL TECHNOLOGIES – TECHNOLOGY PRIORITIES outline

- Enabling further innovation Transformational impact across the chemical sector co-development and/or implementation;
- in Advanced Materials and Advanced Processes;
- Covering the entire production life cycle: R&D, production operations, supply chain and sales processes;
- Key on operational excellence, safety and sustainability improvements [incl. circular supply chains & industrial symbiosis].

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> Laboratory 4.0 - Digital R& D;
> Process Analytical technologies (PAT);
> Cognitive plants: (real-time) process simulation, monitoring, control and optimization;
> Advanced (big-) data analytics and Artificial Intelligence;
> Predictive maintenance;
> Digital support of operators and human-process interfaces;
> Data sharing platforms and data security;
> Coordination and management of connected processes at different levels;
> Distributed ledger technologies.