Stakeholder Event 2023

Advanced Materials & Safe and Sustainable-by-Design Framework: Lighthouse matters for the future of European Research and Innovation
Opening and welcome

Eva Schillinger, SusChem Manager/ NTPs Coordinator
COMPETITION LAW
CHECKLIST FOR MEETINGS

DO

Ensure strict performance in areas of:

Oversight / Supervision
• Have a Cefic/Sector Group Secretariat representative at each meeting
• Consult with appropriate counsel on all questions related to competition law;
• Limit meeting discussions to agenda topics;
• Provide each attendee with a copy of this checklist and have a copy available for reference at all meetings.

Recordkeeping
• Have an agenda and minutes which accurately reflect the matters which occur;
• Ensure the review of agendas, minutes and other important documents by appropriate staff or counsel, in advance of distribution;
• Fully describe the purposes, structures and authorities of the groups.

Vigilance
• Protest any discussion or meeting activities which appear to violate this checklist; ask for those activities to be stopped so that appropriate legal check can be made by counsel; dissociate yourself from any such discussion or activities and for the attendees, leave any meeting in which they continue (and have it minuted).

DON’T

Do not, in fact or appearance, discuss or exchange information not in conformity with competition law, including for example on:

Prices, including
• Individual company/industry prices changes, price differentials, discounts, allowances, credit terms, etc;
• Individual company data on costs, production, capacity (other than nameplates capacities), inventories, sales, etc.

Production, including
• Plans of individual companies concerning the design, production, distribution or marketing of particular products, including proposed territories or customers
• Changes in industry production capacity (other than nameplates capacities) or inventories, etc.

Transportation rates
• Rates or rate policies for individual shipments, including basing point systems, zone prices, freight, etc.

Market procedures, including
• Company bids on contracts for particular products; company procedures for responding to bid invitations;
• Matters relating to actual or potential individual suppliers or customers that might have the effect of excluding them from any market or influencing the business conduct of firms towards them, etc;
• Blacklist or boycott customers or suppliers.

This checklist is for the conduct of Cefic-sponsored meetings. Prohibited discussion topics apply equally to social gatherings incidental to those meetings. The checklist is not exhaustive.
In case of doubt, contact Quentin Silvestre, Senior Legal Advisor at qsi@cefic.be.
Agenda - Morning

09:30 - 09:40 Opening and welcome
E. Schillinger, SusChem Manager/ NTPs Coordinator

09:40 - 10:00 Opening by SusChem Chairman
J.R. Wiinsch, Senior Vice President at BASF SE

10:00 - 10:30 The Transition Pathway for the Chemical Industry
Hans Ingels, Head of Unit for Bioeconomy, Chemicals and Cosmetics – European Commission - DG for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW)

10:30 - 10:45 Coffee break

10:45 - 12:30 Safe and Sustainable-by-Design (SSbD)/ IRISS block
IRISS is the International ecosystem for accelerating the transition to Safe-and-Sustainable-by-Design materials, products and processes
- 10:45-11:05 Introduction to Sustainability assessment frameworks and to the European Partnership for the Assessment of Risks from Chemicals (PARC)
  Lys Hernandez, Senior scientific advisor RIVM
- 11:05-11:25 Overview of the IRISS project – strategic perspective
  Emma Strömberg, Senior researcher polymeric materials and IRISS project coordinator, IVL
- 11:25-11:45 SusChem NTP activities within IRISS
  Barbara Tišler, SusChem Slovenia;
  Stelios Bikos, SusChem Greece;
  Reinier Grimbergen, SusChem Netherlands
- 11:45-12:30: Panel discussion on the implementation of the SSbD framework
  Sofie Norager, Deputy Head of Unit European Commission
  Directorate-General for Research and Innovation - Prosperity - Industrial Transformation
  Irantzu Garinendla Aguirre, Project Officer,
  European Commission Joint Research Centre
  Lys Hernandez, RIVM
  Barbara Tišler, SusChem Slovenia
  Emma Strömberg, IVL.
  Moderator: Eva Schillinger, SusChem

12:30 - 13:30 Lunch
SusChem National Technology Platforms (NTPs) stand area opening

13:30 - 14:00 NTP stands and networking
### Agenda - Afternoon

**Keynote: Feedstock needs to achieve climate neutrality**

*Michael Carus, nova-Institut*

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<th>Speaker</th>
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**Two parallel breakout sessions:**

- **AM2030: Delivering on the Materials Manifesto – what is needed to (re-)gain EU Advanced Materials technology leadership?**
  - *Moderator: Philippe Jacques, EMIRIAM2030, SusChem Board Member*

- **Implementation of the SSbD framework: needs, challenges, opportunities for the SusChem community**
  - *Moderator: Thomas Görgen, Covestro, SusChem Board Member*

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**Coffee break**

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**Summary parallel sessions**

- *Philippe Jacques, EMIRIAM2030*
- *Thomas Görgen, Covestro*

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**Panel discussion on Advanced Materials**

"Which challenges do advanced materials need to overcome to deliver on the Green Deal targets and EU strategic autonomy?"

- *Jürgen Tiedje, Head of Unit European Commission Directorate-General for Research and Innovation - Prosperity - Industrial Transformation*
- *Nicolas Cuadra-Mauroux, Chief Technology Officer Solvay*
- *Katja Loos, Professor for Polymer Science and Applied Chemistry Rijksuniversiteit Groningen*
- *Fabian Weinhandl, Head of GreenTech solutions at BDI*
- *Paul Costerunke, Senior Consultant Lux Research*
- *Moderator: Eva Schillinger, SusChem*

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**Closing remarks**

- *J.R. Wünsch, Senior Vice President at BASF SE*

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<td>17:15</td>
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**Networking & cocktails**

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Opening by SusChem Chairman

Josef WÜNSCH, Senior Vice President at BASF SE
Keynote speech from the European Commission on the Transition Pathway for the Chemical Industry

Hans INGELS, Head of Unit for Bioeconomy, Chemicals and Cosmetics – European Commission - DG for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW)
Transition Pathway for the Chemical Industry

SusChem Stakeholder Event
21st February 2023, La Plaza Hotel - Brussels
1. Background
The 2021 updated Industrial Strategy

COM(2021) 350 final

- To co-create, in partnership with industry, public authorities, social partners and other stakeholders, **transition pathways** for ecosystems, where needed.

- Pathways offer a better bottom-up understanding of the **scale, cost, long-term benefits and conditions** of the required action to accompany the **twin transition** for the most relevant ecosystems, leading to an actionable plan in favour of sustainable competitiveness.

- **Priority to** tourism and energy-intensive industries (incl. **chemicals** and steel).
The changing landscape for the EU chemical industry (1)

- Global market share
  - Decreasing pattern (2030 forecast)

- Energy prices
  - Increasing, unstable

- Geopolitics
  - Russian war of aggression against Ukraine;
  - China zero-Covid policy;

- Technology
  - Alternative feedstock
  - Digitalisation
The changing landscape for the EU chemical industry (2)

- **Climate**

- **Energy**
  - REPowerEU
  - Renewable Energy Directive
  - Industrial Emission Directive

- **Chemicals Strategy for Sustainability**
  - Restriction Roadmap
  - Safe and Sustainable by Design
  - Toxic-free environment

- **Resilience**
  - Update of the Industrial Strategy
  - Due Diligence in the Supply Chain
  - Advanced Materials manifesto and the critical raw material strategy

- **Digitalization**
  - Digitalisation of Chemical Production
  - Data sharing
  - Product Passport
2. The outcome
The transition pathway for the Chemical Industry

- Publication: 27 January 2023
- Actionable plan co-developed by the European Commission with EU Member States, industry, NGOs and other stakeholders
- Based on 8 building blocks developed by Industrial Forum

- Sustainable competitiveness
- Investment and funding
- Research and Innovation
- Regulation and Public Governance
- Access to energy and feedstock
- Infrastructure
- Skills
- Social dimension

- It identifies about 190 actions needed for the twin transition and increased resilience
<table>
<thead>
<tr>
<th>Building Blocks</th>
<th>Topics</th>
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</table>
| **1. Sustainable Competitiveness** | Topic 1: International competitiveness  
Topic 2: Reduction of unsustainable dependencies and supply chains vulnerabilities  
Topic 3: Safety and Sustainability  
Topic 4: Innovation and growth of SMEs  
Topic 5: New synergies |
| **2. Investments and Funding** | Topic 6: Fund for Green Investments  
Topic 7: Access to Funding |
| **3. R&I, Techniques and Technological Solutions** | Topic 8: Better conceptualisation of new techniques and technical solutions (TRL 1 to 5)  
Topic 9: Developing new techniques and technological solutions (TRL 6 to 7)  
Topic 10: Deployment of new techniques and technological solutions (TRL 8 to 9) |
| **4. Regulation and Public Governance (Legislation)** | Topic 11: More effective and predictable regulation  
Topic 12: Vertically and horizontally coherent legislation  
Topic 13: Effective and efficient enforcement |
| **5. Access to energy and feedstock** | Topic 14: Anticipate long-term needs for Energy and Resource Supply  
Topic 15: Economically viable purchase of clean energy  
Topic 16: Feedstock Substitution  
Topic 17: Process and resource efficiency |
| **6. Infrastructure** | Topic 18: Large-scale electricity and hydrogen infrastructure  
Topic 19: Development of new sustainable production facilities  
Topic 20: Sustainable transport of raw materials and chemical products  
Topic 21: Deployment of digital technologies  
Topic 22: Circularity: recycling and reuse infrastructure |
| **7. Skills** | Topic 23: Education (reskilling/upskilling the workforce)  
Topic 24: Sufficient supply of jobs at technical level |
| **8. Social Dimension** | Topic 25: Impact on workforce and consumers  
Topic 26: Improve gender diversity and equality in the sector |
Example: sustainable competitiveness

- **Relevance for EU economy:**
  - EU chemical industry 4\textsuperscript{th} largest industry in Europe (€499 bln sales in 2020);
  - However, its global market share is declining and forecasted to decline;
  - Therefore, need to ensure industry’s continued competitiveness becoming more sustainable.

- **What should the industry do? (some examples)**

  **Topic 1: International competitiveness**
  - **Drive international competitiveness**
    - Analyse medium to long-term impacts of energy crisis on sustainable competitiveness
    - KPIs and Sustainable Development indicators
  - **Promote the market for sustainable products**
    - SSbD framework
    - ‘market pull’ and incentives: sustainable products with higher costs

  **Topic 5: New synergies**
  - **Facilitate the exchange of information**
    - Euroclusters initiative
  - **Increase collaboration to de-risk investments**
    - cross-border projects on the generation and supply of energy and feedstock
  - **Partnerships for innovation**
    - Ensure shared access to the research and technology infrastructures as part of the European Research Area
    - joint cross-sectoral projects that qualify IPCEIs

  **Topic 2: Reduction of unsustainable dependencies and supply-chain vulnerabilities**
  - **Gather supply-chain information**
    - Undertake a strategic foresight exercise focusing on the EU open strategic autonomy (link with critical raw materials)
    - Assess the need to build up and maintain strategic stocks of critical raw materials within the EU
The outcome: a roadmap for the transition

1. An action-oriented component grouping the topics under three cross-cutting themes: collaboration for innovation; clean energy supply; and feedstock diversification.

2. A technology component identifying electrification, hydrogen, biomass, waste, Carbon Capture and Utilization (CCU) & Carbon Capture and Storage (CCS), as well as process efficiency as key technological contributors to the transition pathway.

3. A regulatory component that collects the existing legislation, including major research and innovation (R&I) initiatives, influencing digital and sustainable development of the chemical industry.
Action-oriented roadmap (1)

**SHORT-TERM**
- 2.1. Gather Supply Chain Information
- 2.2. Increase collaboration within sub-sectors
- 3.2. Improve collaboration in value chains
- 4.3. Strengthen initiatives with SMEs under the European Innovation Council (EIC)
- 5.1. Facilitate exchange of information
- 5.2. Increase collaboration to de-risk investments
- 5.3. Support the development of partnerships for innovation
- 7.2. Provide a coordinated platform for funding
- 9.1. Foster collaboration and partnerships (R&I)

**MEDIUM-TERM**
- 2.3. Make the most of existing international partnerships, including FTAs
- 6.2. Develop hub structures

**LONG-TERM**
- 20.1. Increase the availability and capacity of multi-modal terminals that are close to industrial clusters
- 21.2. Deploy technologies to improve chemical manufacturing processes and data gathering
- 22.2. Improve the management of logistics for waste feedstock
- 25.1. Regional cohesion
Action-oriented roadmap (2)

**SHORT-TERM**

10.1. Permitting and commercialisation

14.1. Anticipate long-term needs for the supply of energy and feedstock resource

15.2. Ensure the competitive supply of clean energy

15.3. Improve Power-Purchase Agreements

18.1. Enable free flow of energy between countries

19.2. Accelerate and improve permitting

**MEDIUM-TERM**

2.4. Increase resource efficiency

6.3. Manage and convert existing assets

**LONG-TERM**

18.2. Develop a separate hydrogen infrastructure at EU level

20.1. Increase the availability and capacity of multi-modal terminals that are close to industrial clusters

20.2. Improve use of rail transport

23.1 Develop skills with a sustainability focus

CLEAN ENERGY SUPPLY
Action-oriented roadmap (3)

**SHORT-TERM**

- 1.2 Promote the market for sustainable products
- 3.3 Support product design and re-design
- 4.4. Support compliance with legislation and funding for new technologies
- 6.1. EU Taxonomy to support the CSS
- 7.1. Strengthen communication channels for European funding
- 8.1. Promote safety and sustainability assessment approaches
- 8.3. Develop industrial technology roadmap
- 9.2. Support for development

**MEDIUM-TERM**

- 10.1. Permitting and commercialisation

**LONG-TERM**

- 11.1. Definitions and concepts
- 11.2. Methods
- 16.1. Identify and develop new and sustainable sources of feedstock
- 16.2; 16.3; 16.4. Biomass, Waste, CO2 as alternative feedstock
- 19.1. Develop recycling facilities and bio-refineries
- 22.1. Set a regulatory framework for the transport of waste
- 22.2. Improve the management of logistics for waste feedstock
- 23.2. Adapt secondary, post-secondary and university education
- 24.2. Increase attractiveness of the sector
- 25.2. Safety and social security of workers
# Technology roadmap

## EU Initiatives supporting Technological Transition (SET Action Plan)

<table>
<thead>
<tr>
<th>Actions (as presented In Building Blocks – Part II)</th>
<th>EU Initiatives</th>
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<tr>
<td>6.2. Develop hub structures</td>
<td>• REPowerEU</td>
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<td>8.3. Development of an industrial technology roadmap</td>
<td>• EU Renewable Directive</td>
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<tr>
<td>14. Anticipate I4 needs for the supply of energy and feedstock resource</td>
<td>• TEN-E Regulation</td>
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<td>15.1. Channel investments for clean energy</td>
<td>• Proposal for a directive on Energy Efficiency</td>
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### A) ELECTRIFICATION

- 6.2. Develop hub structures
- 8.3. Development of an industrial technology roadmap
- 14. Anticipate I4 needs for the supply of energy and feedstock resource
- 15.1. Channel investments for clean energy
- 15.2. Ensure competitive supply of clean energy
- 15.3. Improve Power-Purchase Agreements
- 18.1. Enable the free flow of energy between countries
- 20.1. Increase availability and capacity of multi-modal terminals close to industrial clusters
- 20.2. Improve use of rail transport

### B) HYDROGEN

- 6.2. Develop hub structures
- 6.3. Manage and convert existing assets
- 15.1. Channel investments for clean energy
- 15.2. Ensure the competitive supply of clean energy
- 18.2. Develop a separate hydrogen infrastructure at EU level

### C) BIOMASS

- 4.3. Strengthen initiatives with SMEs under the EIC
- 8.1. Promote safety and sustainability assessment approaches
- 9.1. Foster collaboration and partnerships
- 16.2. Biomass as an alternative feedstock
- 19.1. Develop recycling facilities and bio-refineries (and exploit synergies with the chemical industry)

### D) WASTE

- 3.2. Improve collaboration in value chains
- 3.3. Support product design and re-design
- 8.1. Promote safety and sustainability assessment approaches
- 11.1. Definitions and concepts
- 11.2. Methods
- 16.3. Waste as an alternative feedstock
- 22.1. Set a regulatory framework for the transport of waste
- 22.2. Improve the management of logistics for waste feedstock

### E) CCU & CCS

- 6.3. Manage and convert existing assets
- 9.2. Support for development
- 16.4. CO₂ as an alternative feedstock
- 22.2. Improve the management of logistics for waste feedstock

### F) PROCESS EFFICIENCY

- 3.2. Improve collaboration in value chains
- 3.3. Support product design and re-design
- 5.1. Facilitate exchange of information (new synergies)
- 5.3. Support the development of Partnerships for Innovation
- 6.3. Manage and convert existing assets
- 17. Process efficiency
- 19.1. Develop recycling facilities and bio-refineries (and exploit synergies with the chemical industry)
- 20.1. Increase the availability and capacity of multi-modal terminals that are close to industrial clusters
- 21.2. Deploy technologies to improve chemical manufacturing processes and data gathering
- 23.2. Safety and social security of workers

### EU Initiatives

- • REPowerEU
- • European Clean Hydrogen Alliance
- • Hydrogen and decarbonised gas market package
- • Revision of the Renewable Energy Directive
- • INCITE (Industrial Emissions Directive)
- • Hub4Circularity
- • Waste Framework Directive
- • Landfill Directive
- • Hub4Circularity
- • Sustainable Carbon Cycle
- • REPowerEU
- • Industrial Symbiosis
- • Revision of the Industrial Emission Directive
3. Co-implementation
Key elements of the Transition Pathway co-implementation process

**Calls for pledges**

*Main objectives*
- Encouraging stakeholders to commit to concrete and measurable actions
- Collect data to inform the monitoring and evaluation process

**Interaction with stakeholders**

*Main objectives*
- Establishing the governance of the process
- Setting priorities

**Monitoring and Evaluation**

*Main objectives*
- Develop KPIs to monitor and assess the actions for the twin transition

**Publications: Annual progress report**

*Main objectives*
- Assessing the status quo of the co-implementation
- Providing evidence on the actions taken and possible synergies among stakeholders
Timeline for the co-implementation in 2023

- **Publication of the Transition Pathway**
  - HLRT CSS 1 Feb

- **Interactions**
  - 1st Co-implementation group meeting
  - 2nd Co-implementation group meeting
  - 3rd Co-implementation group meeting
  - Industry days
  - Annual progress report

- **Timeline**
  - Q1 2023
    - Jan: Call preparation
      - Merge of the actions/sub-topics/topics in the transition pathway
      - Providing guidance for the interested stakeholders to submit their pledges
    - Feb: Run call for pledges
    - Mar: Ongoing assessment of the pledges received
  - Q2 2023
    - Apr: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc
  - Q3 2023
    - May: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc
    - Jun: Ongoing assessment of the pledges received
  - Q4 2023
    - Jul: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc
    - Aug: Ongoing assessment of the pledges received
    - Sep: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc
    - Oct: Ongoing assessment of the pledges received
    - Nov: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc
    - Dec: Ongoing assessment of the pledges received
  - Q1 2024
    - Jan: Promoting pledges and engage stakeholders via group, 1:1 meetings, events, etc

- **Calls for pledges**
  - Q1 2023
    - Jan: Call preparation
    - Feb: Run call for pledges
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- **Publications**
  - Q1 2023
    - Jan: Publication of the Transition Pathway
  - Q2 2023
    - Apr: Transition Pathway
  - Q3 2023
    - Jul: Transition Pathway
  - Q4 2023
    - Oct: Transition Pathway
  - Q1 2024
    - Jan: Transition Pathway

- **Monitor and evaluation**
  - Q4 2023
    - Evaluating the commitments towards the twin transition and increased resilience.
  - Q1 2024
    - Annual survey

- **Development of indicators**
  - Q4 2023
    - Develop a set of indicators for the transition pathway for the Chemical Industry
Thank you!
Safe and Sustainable-by-Design (SSbD)/IRISS block

IRISS is the International ecosystem for accelerating the transition to Safe-and-Sustainable-by-Design materials, products and processes
Introduction to Sustainability assessment frameworks and to the European Partnership for the Assessment of Risks from Chemicals (PARC)

Lya HERNANDEZ, Senior Scientific Advisor RIVM
Overview of the IRISS project – strategic perspective

Emma STRÖMBERG, Senior researcher polymeric materials and IRISS project coordinator, IVL
The international ecosystem for accelerating the transition to Safe-and-Sustainable-by-design materials, products and processes

Emma Strömberg
IVL Swedish Environmental Research Institute
The IRISS project aims to connect, synergize and transform the SSbD community in Europe and globally towards a life cycle thinking:

- Develop a **global permanent network** for long term cooperation between the networking members, engaging partners beyond the consortium, throughout and beyond the duration of the project.
- Strongly support the **SSbD implementation** in industry **along value chains** to achieve more safe and sustainable products for society.
- Focus on **materials including both products and processes**, considering the extensive progress to-date in chemicals and nanotechnology fields.
- Establish cooperation mechanisms with relevant international initiatives to **align** and leverage the extensive international community.
- Establish **synergy** with industry, EC and the projects that are working with SSbD concepts.
- Building, sharing and transferring the **skills and knowledge** on SSbD.
Mapping SSbD methods and criteria

- State-of-the-art on Safe-by-design criteria and methods for materials and products (included in present regulations, operationalization or implementation of Safe-by design, examples of actual applications of safe-by-design)
- Methods will be mapped along the whole design and innovation processes (Stage Gate Model)
- Safety in materials (environmental and human hazards), production (worker exposure and safety, release during production) and use (use-phase exposure and end of life)
- Existing sustainability criteria initiatives (Ecolabels, Ecodesign directive...)
- Existing SSbD frameworks
- Mapping of developed sustainable methods, tools and criteria applied in industry and in R&D projects
  - Analysis of case studies
  - Deeper analysis of most relevant cases/companies/projects by interviews
- Engineering tools for the implementation of SSbD principles at design stage
- Sustainability Environmental dimension: LCA (Life Cycle Assessment), Social dimension: S-LCA
Survey on Mapping of SSbD initiatives

Content of the survey

• **SSbD principles** to be applied in the design
• **Engineering tools** for the implementation of SSbD principles at design stage
• **Safe by design** (SbD)
• Sustainability **Environmental** dimension: LCA
• End of life and design for **circular economy**
• Sustainability **Social** dimension: S-LCA
• **Skills** on SSbD
• SSbD **gaps**

Survey sent out to map the state-of-the-art of methods and criteria of existing SSbD approaches, covering safe materials, processes and products, including environmental impact, life-cycle costing and social impact.
Design guiding principles are proposed to support the design of chemical and materials:
- Green chemistry
- Green Engineering
- Sustainable Chemistry
- Safe by design

List of SSbD principles recommended by the JRC SSbD framework:

- SSBD1: Material efficiency
- SSBD2: Minimize the use of hazardous materials
- SSBD3: Design for energy efficiency
- SSBD4: Use renewable sources
- SSBD5: Prevent and avoid hazardous emissions
- SSBD6: Reduce exposure to hazardous substances
- SSBD7: Design for end of life
- SSBD8: Consider the whole Life Cycle

Applicability of SSbD principles:

- SSBD8.2: Efficient recyclability
- SSBD8.1: Design to last
- SSBD8: Consider the whole Life Cycle
- SSBD7: Design for end of life
- SSBD6: Reduce exposure to... (truncated)
- SSBD5: Avoid hazardous...
- SSBD4: Use renewable sources
- SSBD3: Design for energy...
- SSBD2: Minimize hazardous...
- SSBD1.2: Minimize solvents and...
- SSBD1.1: Minimize raw materials
- SSBD1: Material efficiency
Preliminary results - Safe by Design (SbD)

Applicability of SbD tools developed/proposed by EU projects/platforms:

- **Yes**: 32%
- **No**: 68%

- **EU project**: 14
- **NanoReg2**: 8
- **SAFERA**: 6
- **Gov4Nano**: 4
- **Pharmas**: 3
- **PREMIER**: 1
- **NANORIGO**: 2

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**Legend**
- Light Blue: 1
- Blue: 2
- Green: 3
- Dark Brown: 4
- Orange: 5
- Dark Green: 6
- Dark Grey: 8
Preliminary results - Environmental dimension: LCA

Use of LCA Databases, Software and Impact Assessment methodologies

19% of the companies that replied use LCA

Databases: ECOINFVENT (100%)
Gap analysis in SSbD activities

- Harmonized methodology to establish the gap analysis approach
  - Aiming to identify suboptimal or missing strategies, structures, practices or skills from the sectors identified and mapped
  - Recommend steps that will offer opportunities for gap closure or approach convergence
  - Consideration of possible gender- and minority-specific aspects of the SSbD concept
- Workshop for stakeholders from HE projects related to SSbD
- Harmonisation of inputs to gap analysis from the NanoSafetyCluster and VCs
- Elaboration of the gap analysis of SSbD criteria, and priorities, including modelling and testing and recycling methodologies
- Map and address SSbD skills mismatches and competence gaps, to support enhancement of adequate skills at all levels - including in university programmes, research, industry and among regulators
Gaps for the SSbD approach to be easily applicable

- A **common understanding** of the SSbD concept is still missing
- A practical guideline and tools on how to implement the SSbD concept are missing
  - At present the **framework is too complex** for companies (SME especially) to comprehend and work with
- Harmonized assessment methodologies for **social and economic aspects** are still missing
- **Data** must be made findable, accessible, interoperable and reusable (FAIR)
- **Harmonized assessment methodologies** and **minimum requirements** need to be defined from the regulatory/policy side (in close cooperation with industry)
  - Threshold values for each SSbD criteria are missing: what is low emission and what is high emission?
- **Education** on SSbD needs to be encouraged within companies
Development of SSbD supportive roadmap

- Development of value chain specific SSbD supportive roadmaps with agendas for:
  - research needs
  - skills, competences and education needs, and
  - knowledge and information sharing needs
- Translate the value chain specific SSbD supportive roadmaps to a generalized roadmap

Packaging
(IPC; Industrial Technical Centre for Plastics and Composites)

Textiles
(ETP; EU Technology Platform for the Future of Textiles & Clothing)

Automotive
(CLEPA; European Association of Automotive Suppliers)

Energy materials
(EMIRI; Energy Materials Industrial Research Initiative)

Electronics
(INL; International Iberian Nanotechnology Laboratory)

Construction
(EFCC; European Federation for Construction Chemicals)
Value chains SSbD ecosystem

- Value chain analysis
- Baseline analysis of SSbD criteria - specificities and common grounds
- Value chain SSbD criteria gap analysis
- Uptake of the SSbD approach by the value chains
- Value chain-specific research and innovation roadmaps
- Engagement with additional value chain networks, internationalization and integration in the permanent structure

- Case studies for implementation of the SSbD framework
Analysis of the value chains, their stakeholders and initiatives

Goals:
• To support the state-of-the-art mapping activities in SSbD
• To obtain first insights on how to translate the EC framework to practical methodologies and tools for SSbD
• To identify the applicability of the framework, alongside challenges and barriers from a value chain perspective

Content:
• Mapping Value Chain Stakeholders
• Main safety and sustainability challenges
• Recommendations on how to bring SSbD to practical applicability
Recommendations from value chains

How to bring SSbd to practice

- SSbd "stamp" or "certification" for chemical material (as Safe certification) available on material datasheets to facilitate the use of these material by product producers
- Facilitate access to experts who can evaluate and validate material or parts. Use model of expert platforms to ease the data access to companies (especially SMEs)
- Producers need to work preferentially with local material producers, in order to facilitate exchanges and improve material knowledge
- Distinguish between vital vs. nice-to-have product performance properties (personal protection vs. fashion effect) & consumer vs. professional products/applications
- Make SSbd practically manageable for SME designers, product developers and manufacturers
- Develop accessible, easy-to-use management tools, platforms, tutorials and trainings
- Well defined and acceptable limits for safety and sustainability criteria, depending on use case and informed by whole life-cycle information
Recommendations from value chains

How to bring SSbD to practice

• Increased dialogue in the value chain and across sectors to raise awareness on parallel challenges and best-practices on design for safety and sustainability

• Continued incentives to innovation, e.g. to support the development of digital tools for supply chain management and more efficient end of life handling

• Innovation always goes with trade-off decisions between safety, sustainability but also performances, cost, user experience, societal benefits,… All dimensions must be considered

• By-design needs enablers: methodologies, digital tools, data, data, data (safety and sustainability data are often missing at the start of the innovation process…)

• SSbD awareness and compliance can be most effectively addressed in the design (and novel concepts) for simple products, e.g., where flexible and organic materials can be used. There are overlaps between electronics, textiles, automotive, and energy value chains

• Build on existing regulations (Reach, Battery directive, product passport,...) and sectorial initiatives/roadmaps (Battery 2030+, Batteries Europe, Batt4EU,...)
Establishment of an EU Led International permanent network

- A structure for continuous cooperation and services to network members, potential members, network associates as well as other stakeholders with interests in SSbD
- Strengthen collaboration and information exchange between relevant actors along the value chains
- Build a platform containing services addressed to different key target groups
  - Training service for SMEs
  - Service for start-ups to boost business collaboration with industry
  - Co-creation service to establish hubs for specific value chains
  - Knowledge exchange services
  - Knowledge sharing services
Towards an efficient science-policy-industry interface

Building structural and efficient information sharing process and network

Science:
Initial steps on operationalization of SSbD
• IRISS-NSC collaboration
• IRISS-PARC collaboration
• IRISS-ongoing H2020 and HE projects
Bringing science to harmonization and standardization
• IRISS-OECD synergies

Policy:
IRISS structural dialogue with:
• EC RTD
• EC JRC

Industry:
Cefic coordinates SusChem NTPs and 6 value chains representatives
• Packaging (IPC; Industrial Technical Centre for Plastics and Composites)
• Textiles (ETP; EU Technology Platform for the Future of Textiles & Clothing)
• Construction chemicals (EFCC; European Federation for Construction Chemicals)
• Automotive (CLEPA; European Association of Automotive Suppliers)
• Energy materials (EMIRI; Energy Materials Industrial Research Initiative)
• Electronics (INL; International Iberian Nanotechnology Laboratory)
• Fragrances (IFRA; The International Fragrance Association) – new VC

Building structural and efficient information sharing process and network

Policy

Industry

Science

Science-Policy-Industry Interphase
Our partners and network

The project receives funding from the European Union’s HORIZON EUROPE research and innovation programme under grant agreement n° 101058245

UK participants in Project IRISS are supported by UKRI grant 10038816

CH participants in Project IRISS receive funding from the Swiss State Secretariat for Education, Research, and Innovation (SERI)
Our partners and network

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

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SusChem NTP activities within IRISS

Barbara Tišler
SusChem Slovenia

Stelios Bikos
SusChem Greece

Reinier Grimbergen
SusChem Netherlands
Panel discussion on the implementation of the SSbD framework
Irantzu

GARMENDIA AGUIRRE

Project Officer, European Commission
Joint Research Centre
Sofie NØRAGER

Deputy Head of Unit European Commission
Directorate-General for Research and Innovation – Prosperity - Industrial Transformation
Panel discussion on the implementation of the SSbD framework

- Sofie Nørager, Deputy Head of Unit European Commission Directorate-General for Research and Innovation - Prosperity - Industrial Transformation, European Commission
- Irantzu Garmendia Aguirre, Project Officer, European Commission, Joint Research Centre
- Lya Hernandez, RIVM
- Barbara Tišler, SusChem Slovenia
- Emma Strömberg, IVL
- Moderator: Eva Schillinger, SusChem
SusChem NTP activities

Dr. Barbara Tišler, member of the leadership team of SusChem NTPs, National Institute of Chemistry, Slovenia – SusChem Slovenia

Dr. Stelios Bikos, president of SusChem Greece

Dr. Reinier Grimbergen, TNO, Chairman of SusChemNL NTP and member of the Board of SusChem ETP
SusChem is a technology solutions provider and also the multi-stakeholder forum.

SusChem National Technology Platforms (NTPs) help to connect SusChem thinking with national and regional programmes.
17 National Technology Platforms

17 SusChem NTPs

Around 20,000 members

SMEs
Industry
Governments
RTOs
Academia
Civil society
Chemistry and related fields

Interlinking of Associations of chemical industries with Academia, research institutes and SMEs and startups
Contributing to development of Strategic Research and Innovation Agenda
5 NTPs covering all regions of Europe actively involved in IRISS

The international ecosystem for accelerating the transition to Safe-and-Sustainable-by-design materials, products and processes
The role of SusChem NTPs in the IRISS project:

• To identify available incentives for the uptake of SSbD criteria and to expand network

• To map potential collaboration-partners from industry, research organisations, universities and society

• to strengthen collaboration and information exchange between relevant actors

• to ensure provision of policy, applied science, industry and innovation linkage throughout EU and beyond, including SMEs and the wider society

• to build a permanent network
Methodology of SusChem NTPs about SSbD concept

From prudence with mobilizing stakeholders on SSbD to active engagement

**Prudence because of:**
Proposed hierarchical approach
It is not clear what the scope and the purpose of the assessment framework is

**Active engagement because:**
We need to spread objective information
We agree with the SSbD principles
We see the benefit of integrating some type of assessment during the innovation process
We encourage Strategic Research and Innovation Plan providing balanced overview of SSbD R&I Challenges
Activities of SusChem NTPs about SSbD concept

From informing to co-creating

Information on SSbD via:
Newsletters
Working groups
Workshops with stakeholders

Co-creation:
Collaborating with local authorities
Collaboration with academia – developing training courses
Within IRISS project large survey was launched about SSbD in practice
An estimation about the interest among SMEs about SSbD-training is challenging as most of the SMEs are not yet aware what it is and if it effects them. However, it can be assumed that they will get attracted by SSbD-training as soon as it is available in a format, that is useful for them.

Awareness rising about SSbD is needed.

New study programmes perfect places for integration of SSbD courses.

Hard and ongoing work.
Regional Structure of SusChem NTP Involvement in IRISS

Structure for clarity & efficiency

- **Collaborating Partners** (NTPs & other Networks)
- **Networking Partners** (Regional Coordinator NTPs)
- **Network Partner College** (all 6 Networking Partners)
- **Network Liaisons** (SI, AT, GR)
- **Core Partners**

- 5 “Regions”
- 6 Regional Leaders
- 17 NTPs
- 34 Countries
Regional Structure of SusChem NTP Involvement in IRISS

South & West
GR

Central & West
AT

Eastern
CZ

Nordic
SE/FI

Balkans
SI
Dissemination Activities

National and Regional Activities

- Mapping of national stakeholders per value chain
- Verification of national stakeholders per value chain
- Optional national workshops on SSbD / IRISS per value chain
- Regional workshops on SSbD / IRISS per value chain

Europe-wide / International Events

- IRISS project events participation
- SSbD / IRISS thematic sessions
Project Activities

Core partner generated questionnaires & surveys
   Passed to Networking Partners
      to distribute to their members and the NTPs and others in their Region
      possibly to distribute to their members, if applicable to fill-in
      …and return to their association / network secretariat
      …to feed back to the Networking Partner
      …to return to the core partners who need the information.

Core partner generated training/informative material: disseminate through workshops, emails and social media
Examples

ES –
An SSbD Working Group has been created
An SSbD Webinar has been held

GR –
48 national stakeholders have been mapped
A S+W Region coordination meeting has been held

NL –
RIVM is the Dutch partner in the IRISS project
An SSbD 1 day symposium has been organized by NWO and ChemistryNL to be held on March 15th in Utrecht:
« Safe and Sustainable by Design: the small molecule challenge »

International Event Participation
Dedicated sessions in:
IndTech 2022, June 2022, Grenoble, FR
ESCAPE33, June 2023, Athens, GR
IUPAC 2023, August 2023, The Hague, NL
NL – SSbD Symposium

«Safe and Sustainable by Design: the small molecule challenge»

- Universities (UvA, RU, UM)
- RTOs (RIVM)
- Chemical Industry (Shell, Avantium)
- Top sector Chemistry (ChemistyNL)
- Branche Organization of the Chemical Industry (VNCI)
- Funding (NWO)
- Government (I&W)

SUSCHEM – Presentation title

PROGRAMME 15 March 2023
Safe and Sustainable-by-design symposium: the small molecule challenge

Venue: NWO Utrecht, Auditorium

09.30 – 10.00 Welcome and coffee
10.00 – 10.05 Opening by Pieter Brujininx
10.05 – 11.05 Lectures
10.05 – 10.45 Lecture background/policy development by Agnes Ooman (RIVM/UvA)
10.45 – 11.05 Lecture synthetic chemist perspective Chris Slootweg (UvA)
11.05 – 11.20 Coffee/tea break
11.20 – 12.20 Lectures
11.20 – 11.50 Lecture environmental chemist perspective by Ad Rappé (RU)
11.50 – 12.20 Lecture ethical perspective by Harro van Lent (UM)
12.20 – 13.15 Lunch break
13.15 – 14.30 Interactive session
13.15 – 13.30 Lecture industrial perspective by Michiel van Kuppevelt (VNCI)
13.30 – 14.20 Panel discussion with Tiny van der Warff (I&W), Gert-Jan Gruter (UvA), Demi Theodori (SER), Elisabeth Reelofs (MVO) and Jean-Paul Lange (Shell)
14.30 – 15.00 Coffee/tea break
15.00 – 16.00 Interactive session - building a community
15.00 – 15.15 Lecture NWA-programme 'Towards a practical Safe-by-Design approach for chemical products and processes' by Annemarie van Wozel
15.15 – 15.30 Open discussion with the audience
15.35 – 15.45 Overview of relevant funding instruments by Marije Goos
15.45 – 16.05 Open discussion with the audience
16.05 – 16.20 Recap and closure
16.20 – 18.00 Drinks
Keynote: Feedstock needs to achieve climate neutrality

Michael CARUS, nova-Institut
Feedstock needs to achieve climate neutrality – deep dive in embedded carbon

Renewable Carbon Concept and Initiative

Michael Carus, founder and CEO nova-Institute & executive manager of RCI
Your partner in strategy, technology and sustainability

SCIENCE-BASED CONSULTANCY ON RENEWABLE CARBON FOR CHEMICALS AND MATERIALS

We support your smart transition to renewable carbon

nova-Institute was founded in 1994 and has a multidisciplinary and international team of more than 40 scientists

Get to know our experts at: nova-institute.eu/nova-team
Feedstock needs to achieve climate neutrality – deep dive in embedded carbon

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nov-Institut GmbH – SME

private and independent research institute; multidisciplinary and international team of more than 40 scientists

Technology & Markets

- Market Research
- Innovation & Technology Scouting
- Trend & Competitive Analysis
- Supply & Demand Analysis
- Feasibility & Potential Studies
- Customised Expert Workshops

Sustainability

- Life Cycle Assessments (ISO 14040/44, PEF Conform)
- Carbon Footprint Studies and Customised Tools
- Initial Sustainability Screenings and Strategy Consultation
- Holistic Sustainability Assessment (incl. Social and Economic Impacts)
- GHG Accounting Following Recognised Accounting Standards
- Critical Reviews for LCA or Carbon Footprint Reports

Communication

- Comprehensive Communication & Dissemination in Research Projects
- Communication & Marketing Support
- Network of 60,000 Contacts to Companies, Associations & Institutes
- Targeted Newsletters for 19 Specialty Areas of the Industry
- Conferences, Workshops & nova Sessions
- In-depth B2C Research

Economy & Policy

- Strategic Consulting for Industry, Policy & NGO’s
- Political Framework, Measures & Instruments
- Standards, Certification & Labelling
- Micro- and Macroeconomics
- Techno-Economic Evaluation (TEE) for Low & High TRL
- Target Price Analysis for Feedstock & Products
Mark and Trend Reports on Renewable Carbon

The Best Available on Bio- an CO₂-based Polymers & Building Blocks and Chemical Recycling

renewable-carbon.eu/commercial-reports
Renewable Carbon Companies (ReCaCo)

- up to 50,000 downloads of company profiles per year
- 128 companies in the database
- easy and direct access to products, services and experts of the renewable carbon economy worldwide – get visible for thousands of customers
- become a part of the ReCaCo with 2 pages for free

www.renewable-carbon.eu/companies
The invisible carbon footprint

- **Ethylene**: 68%
  - Embedded: 68%
  - Production: 0%

- **Propylene**: 68%
  - Embedded: 68%
  - Production: 0%

- **Butadiene**: 73%
  - Embedded: 73%
  - Production: 0%

- **Benzene**: 65%
  - Embedded: 65%
  - Production: 0%

- **Toluene**: 73%
  - Embedded: 73%
  - Production: 0%

- **p-Xylene**: 70%
  - Embedded: 70%
  - Production: 0%

All figures available at www.bio-based.eu/markets

Ethylene, propylene, butadiene – Calculations by nova-Institute
Benzene, toluene, p-xylene – Source: BioBTX
Global Demand for Carbon Embedded in Materials and Chemicals

Total: 1200 Mt embedded C/yr  Reference Years: 2015–2022

- Textiles (natural): 14 Mt embedded C/yr (1%)
- Pulp & Paper: 160 Mt embedded C/yr (13%)
- Wood Construction & Furniture: 350 Mt embedded C/yr (28%)
- Chemicals & Derived Materials: 550 Mt embedded C/yr (44%)
- Heavy Oil Fraction: 160 Mt embedded C/yr

Fossil-based: 640 Mt embedded C/yr
Bio-based: 460 Mt embedded C/yr
Recycling: 130 Mt embedded C/yr

Main Sources: updated data using methodology based on Piotrowski et al. 2015, Levi and Cullen 2018, Plastics Europe 2022b, Skoczinski et al. 2022, FAO Global Forest Resource Assessment 2020

available at www.renewable-carbon.eu/graphics

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Global Supply for Embedded Carbon in Chemicals and Derived Materials by Type of Feedstock

Total: **550 Mt embedded C/yr**

Reference Years: **2015–2022**

- Fossil-based: **480 Mt embedded C/yr**
- Bio-based: **41 Mt embedded C/yr**
- Recycling: **24 Mt embedded C/yr**
- CO₂-based: **0.2 Mt embedded C/yr**
Consumption of Embedded Carbon for Global Chemicals and Derived Materials by Carbon Feedstock

Total: **550 Mt embedded C/yr**
Reference Years: **2015–2022**

- Fossil-based: **480 Mt embedded C/yr**
- Bio-based: **41 Mt embedded C/yr**
- Recycling: **24 Mt embedded C/yr**
- CO₂-based: **0.2 Mt embedded C/yr**

Available at [www.renewable-carbon.eu/graphics](http://www.renewable-carbon.eu/graphics)

Main Sources: Updated data using methodology based on Piotrowski et al. 2015, Levi and Cullen 2018, Plastics Europe 2022b, Skoczinski et al. 2022, The Fibre Year Consulting 2022, ETRMA 2021
### Summary of global carbon flows today (Mt C / yr)

<table>
<thead>
<tr>
<th></th>
<th>World¹</th>
<th>Global Materials &amp; Chemicals²,³</th>
<th>Global Chemical Industry²,⁴</th>
<th>Global Chemicals &amp; Derived Materials²,⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>17000</td>
<td>1200</td>
<td>710</td>
<td>550</td>
</tr>
<tr>
<td><strong>Fossil total</strong></td>
<td>11000</td>
<td>640</td>
<td>640</td>
<td>480</td>
</tr>
<tr>
<td>Coal</td>
<td>4700</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Gas</td>
<td>2500</td>
<td>140</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Oil</td>
<td>3800</td>
<td>490</td>
<td>490</td>
<td>330</td>
</tr>
<tr>
<td><strong>Primary Biomass</strong></td>
<td>6100</td>
<td>460</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Cellulose</td>
<td>2700</td>
<td>370</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sugar &amp; Starch</td>
<td>1300</td>
<td>10</td>
<td>6</td>
<td>6</td>
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<tr>
<td>Fat/Oil</td>
<td>500</td>
<td>14</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Protein</td>
<td>800</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others⁶</td>
<td>800</td>
<td>63</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Recyclates, Secondary biomass</strong></td>
<td>280⁷</td>
<td>130</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

1. Includes carbon input of fossil and biogenic raw materials plus recyclates in the world economy (food and feed, energy sector, transport, materials and chemicals)
2. Only embedded carbon; energetic use excluded
3. Includes chemicals and derived materials (plastics, rubber), including the heavy oil fraction (bitumen, paraffin waxes, lubricants) and bio-based industries (wood for construction, pulp & paper, textiles)
4. Includes chemicals and derived materials (plastics, rubber), including the heavy oil fraction (bitumen, paraffin waxes, lubricants)
5. Includes chemicals and derived materials (plastics, rubber)
6. Includes lignin, natural rubber, etc
7. Includes material recycling and incineration Various sources; Various reference years, mainly 2018–2020
Flows of organic carbon in the EU-27 material & chemical sector

- Total landfill: 13 Mt C
- Wood product landfill: 5 Mt C
- Pulp & paper landfill: 3 Mt C
- Total energy recovery: 15 Mt C
- Plastic incineration: 9 Mt C
- Wood product incineration: 5 Mt C
- Pulp & paper incineration: 2 Mt C
- Plastic waste export: 1 Mt C

Biomass feedstock: 56 Mt C
- Wood (construction & furniture): 44 Mt C
  - Wood (construction & furniture) biomass: 40 Mt C
  - Wood (construction & furniture) recycling: 4 Mt C
- Pulp & paper: 36 Mt C
  - Pulp & Paper: 21 Mt C
  - Pulp & paper recycling: 15 Mt C
- Chemical industry: 120 Mt C
  - Plastic recyclates: 4 Mt C
  - Bio-based chemicals & materials: 5 Mt C
- Fossil Chemicals & Materials: 115 Mt C
  - Other organic basic chemicals: 54 Mt C
  - Synthetic rubber: 3 Mt C
  - Dyes & pigments: 3 Mt C

Raw material input: 180 Mt C
Raw material input + secondary materials: 200 Mt C

nova-Institute 2023
Reference Years: 2018 (waste); 2019, 2020 (others)

Differences in Supply and Demand due to losses and data inconsistencies. Values rounded to the second significant digit.
EU-27 Demand for Embedded Carbon in Materials and Chemicals
by Sectors; Total: 200 Mt embedded C/yr Reference Years: 2018–2021

- Textiles (natural): 1 Mt embedded C/yr (1%)
- Pulp & Paper: 36 Mt embedded C/yr (17%)
- Wood Construction & Furniture: 44 Mt embedded C/yr (21%)
- Heavy Oil Fraction: 14 Mt embedded C/yr (7%)
- Chemicals & Derived Materials: 110 Mt embedded C/yr (54%)

- Fossil-based: 115 Mt embedded C/yr
- Bio-based: 66 Mt embedded C/yr
- Recycling: 23 Mt embedded C/yr

available at www.renewable-carbon.eu/graphics
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Carbon Demand for Embedded Carbon in the EU-27 Chemical Industry

Total: 120 Mt embedded C/yr  Reference Years: 2018–2021

- C20.13 Other Organic Basic Chemicals 54 Mt C/yr
- C20.12 Dyes and Pigments 2.5 Mt C/yr
- Heavy Oil Fraction (Bitumen, Lubricants, Paraffin Waxes) 14 Mt C/yr
- C20.16 Plastics in Primary Forms 51 Mt C/yr
- C20.17 Synthetic Rubber in Primary Forms 2.8 Mt C/yr

Fossil-based: 115 Mt embedded C/yr
Bio-based: 5.1 Mt embedded C/yr
Recycling: 4.1 Mt embedded C/yr

available at www.renewable-carbon.eu/graphics

Main sources: Own Data Based on Eurostat prodcod 2022, NACE class C20.1, Eurostat energy balance 2018, Plastics Europe 2022b, Plastic recyclates
## Summary of EU-27 carbon flows today (Mt C / yr)

<table>
<thead>
<tr>
<th></th>
<th>EU-27(^1)</th>
<th>EU-27 Materials &amp; chemicals(^2,3)</th>
<th>EU-27 Chemical industry(^2,4)</th>
<th>EU-27 Chemicals &amp; derived materials(^2,5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>1700</td>
<td>100 %</td>
<td>200</td>
<td>100 %</td>
</tr>
<tr>
<td><strong>Fossil total</strong></td>
<td>1100</td>
<td>67 %</td>
<td>115</td>
<td>93 %</td>
</tr>
<tr>
<td>Coal</td>
<td>180</td>
<td>2.7</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td>270</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>670</td>
<td>96</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Primary Biomass</td>
<td>500</td>
<td>30 %</td>
<td>66</td>
<td>4 %</td>
</tr>
<tr>
<td>Cellulose</td>
<td>185</td>
<td>55</td>
<td>0.5</td>
<td>0.5</td>
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<tr>
<td>Sugar &amp; Starch</td>
<td>145</td>
<td>2</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Fat/Oil</td>
<td>54</td>
<td>2</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Protein</td>
<td>58</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Others(^6)</td>
<td>53</td>
<td>8</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Recyclates,</td>
<td>38(^7)</td>
<td>3 %</td>
<td>23</td>
<td>3 %</td>
</tr>
<tr>
<td>Secondary biomass</td>
<td></td>
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</tbody>
</table>

1 - includes carbon input of fossil and biogenic raw materials plus recyclates in the world economy (food and feed, energy sector, transport, materials and chemicals)
2 - only embedded carbon; energetic use excluded
3 - includes chemicals and derived materials (plastics, rubber), including the heavy oil fraction (bitumen, paraffin waxes, lubricants) and bio-based industries (wood for construction, pulp & paper, textiles)
4 - includes chemicals and derived materials (plastics, rubber), including the heavy oil fraction (bitumen, paraffin waxes, lubricants)
5 - includes chemicals and derived materials (plastics, rubber)
6 - includes lignin, natural rubber, etc
7 - includes material recycling and incineration

Various sources; Various reference years, mainly 2018-2020
Renewable Carbon from Biomass

Pros in a nutshell
• Food crops:
  • Commodities, established in high volume, good logistics
  • Food crops: Protein-rich by-products
• Wide range of non-food feedstocks – no direct food competition, positive image
  • wood and lignocellulosic by-products and side streams
  • biogenic waste from industry and households
• Low GHG footprint compared with fossil resources
• New green chemical pathways
• Biotechnology as sustainable process technology

Cons in a nutshell
• Limited total volume
• Low land-efficiency
• Potential pressure on land and biodiversity
• Potential competition with food crops and a possible threat to food security
The 0.028 % share of biomass used to produce bio-based polymers translates into an area share of only 0.007 %. This is due to various factors: high-yielding crops (like sugarcane and maize) are used for the production of bio-based polymers, leading to a high area efficiency; the yields are not only used for polymer production but also for animal feed (the protein share) and thus only a part is allocated; and finally, because the biomass is a process by-product that uses no land (such as glycerol).
Renewable Carbon from CO₂

Pros in a nutshell

• Very high potential in volume (almost unlimited)
• Low demand for land and water, low carbon footprint
• High TRL technologies available
• Almost all chemicals and plastics can be produced from CO₂
• High employment potential
• Inexhaustible source of carbon for the next millennia
• Even “black” CO₂ carbon utilisation lead to relevant GHG reduction

Cons in a nutshell

• Potential lock in effects using fossil point sources
• Competition on limited renewable electricity
• High investment necessary
• Global carbon demand today: 450 Mt C (embedded carbon for chemicals)
• 2050 scenario: 1,000 Mt C
• To supply 1,000 Mt C
  • 11,000 kWh / t\text{methanol}
  • 29 PWh\text{el} / year is required
  • 117,000 km\textsuperscript{2} desert area is required
  • 1.3% of the Sahara desert
• Using completely decarbonised renewable energy, the reduction potential is 3.7 Gt CO\textsubscript{2} / year
• Global CO\textsubscript{2} emissions today: 55 Gt CO\textsubscript{2} / year
Pros in a nutshell

• Most important end-of-life option for plastics in the future circular economy
• Strong recycling targets in the European Union will guarantee access to renewable carbon from recycling
• Chemical recycling (different technologies): Basically no loss of quality compared to virgin feedstock

Cons in a nutshell

• Mechanical recycling: Limitation in quality, not allowed in many food applications
• Energy intensive processes
• Chemical recycling: early stage, first assessments on economic and environmental impacts available; investments waiting for clear political framework
Major challenges for chemical companies looking to switch from fossil to renewable carbon – the biggest transformation since industrial revolution

• Which Carbon feedstocks will be accepted and supported by policy in medium and long term?
• Which carbon will be available in sufficient quantities in the medium and long term to compete with the strongly supported bioenergy, biofuels and BECSS?
• How can the competitiveness gap be bridged during the transformation phase?
• When will there be clear framework conditions and political support?

The Risk: Without a clear policy framework and robust strategies, investments in a non-fossil / renewable chemical industry will be delayed and shifted to Asia and North America. This is already happening and Europe is losing innovation, sustainability options and competitiveness in a core industrial sector – threatening to cause dependencies that dwarf those on Russian crude oil and natural gas.

The Commission’s paper on sustainable carbon cycles (Dec. 2021) was a milestone that gave hope to chemical innovators, but so far without concrete follow-up.
Where to invest and support?

Biomass

- **Food crops** – huge concerns that are not backed up by evidence; competition with bioenergy & biofuels
- **Cultivated agricultural biomass** – some member states expand the food crop concerns to non-food
- **Wood** – huge competition with subsidized bioenergy, advanced biofuels, bio-kerosine and BECCS
- **Biogenic side streams, by-products and waste** – huge competition with subsidized bioenergy, advanced biofuels, bio-kerosine and BECCS (REDII/III)
- **Demand for sustainability certificates** without providing any incentives
- Concerns to accept **Mass Balance and Free Attribution** (MBFA)

**CO₂ utilisation, CCU / PtX**

- **Biogenic CO₂ and Direct Air capture** – strong competition with e-fuels/kerosene (RED), BECCS and CDR; no support for BECCU
- **Fossil CO₂** – missing acceptance and competition with e-fuels/kerosene (RED) and CCS; no support for CCU; not part of ETS

Recycling

- **Chemical recycling** as a important carbon feedstock option – concerns and barriers, not counting in the recycling quota
- Concerns to accept **Mass Balance and Free Attribution** (MBFA)
Joel A. Tickner, Ken Geiser & Stephanie Baima (2022) Transitioning the Chemical Industry: Elements of a Roadmap Toward Sustainable Chemicals and Materials, Environment: Science and Policy for Sustainable Development

Figure 1.

Five Conversion Strategies To Transition the Chemical Industry Toward Sustainability

- **Energy Conversion**: The industry should minimize its process energy requirements and transition from fossil fuels to renewables.
- **Feedstock Substitution**: The industry should sharply reduce fossil fuel use for feedstocks in the production of chemicals, while building supplies of alternative sustainable, renewable feedstocks.
- **Production Process Redesign**: Chemical manufacturing processes should be redesigned to use renewable feedstocks, minimize adverse impacts, and work within more flexible, distributed, and resilient manufacturing operations.
- **Molecular Redesign**: The industry should develop innovative, new platform and tunable chemistries based on the principles of green chemistry and engineering.
- **Downstream Product Redesign**: Product design and delivery should be reimagined so that products are more circular, use safer chemistries, and have lower adverse impacts through their lifecycle.

Source: David Gerrati/DG Communications.
Embedded Carbon Demand for Main Sectors

Today (2015–2020) and Scenario for 2050 (in Million Tonnes of Embedded Carbon)

- **ENERGY**
  - Today: 8000
  - 2050: 3000
  - Reduction: -50%

- **TRANSPORT**
  - Today: 6000
  - 2050: 600
  - Reduction: -90%

- **MATERIALS & CHEMICALS**
  - Today: 1200
  - 2050: 2400
  - Increase: +100%

Legend:
- CO₂-based
- Recycling
- Bio-based
- Fossil-based

Available at www.renewable-carbon.eu/graphics

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Carbon Embedded in the Heavy Oil Fraction
(Bitumen, Lubricants, Paraffin Waxes)

Carbon demand in million tonnes of embedded carbon

- Fossil-based 100% in 2020
- CAGR 2.5%
- 340 Mt C in 2050
  - 40% Bio-based
  - 20% CO2-based
  - 40% Recycling

Available at www.renewable-carbon.eu/graphics
## Nine Recent Studies on the Future of Chemical Industry: A Deeper Look at Scenarios on the Supply of Alternative Carbon Feedstocks

<table>
<thead>
<tr>
<th>Report</th>
<th>Scope</th>
<th>CAGR</th>
<th>Share Bio-based</th>
<th>Share CO₂-based</th>
<th>Share Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ishii et al. / Systemiq 2022</td>
<td>Chemical Industry (cracker) 2020–2050</td>
<td>3%</td>
<td>up to 43%</td>
<td>up to 45%</td>
<td>up to 3%¹)</td>
</tr>
<tr>
<td>OECD 2022</td>
<td>Plastic Sector 2019–2060</td>
<td>2.4%</td>
<td>3%</td>
<td>–</td>
<td>12%</td>
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<tr>
<td>RCI/nova 2023</td>
<td>Chemical Industry (cracker &amp; more) 2020–2050</td>
<td>2.5%</td>
<td>20%</td>
<td>25%</td>
<td>55%</td>
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<tr>
<td>RCI/nova 2023</td>
<td>Chemical Industry (heavy oil fraction) 2050</td>
<td>2.5%</td>
<td>40% (mainly lignin &amp; pyrolysis oil)</td>
<td>20% (mainly FT)</td>
<td>40% (pyrolysis oil)</td>
</tr>
<tr>
<td>Lange, J.-P. 2021 (Shell)</td>
<td>Chemical Industry (cracker &amp; more) 2020–2100</td>
<td>a) 4% by 2050, 2% by 2100</td>
<td>40% (1G 10%, 2G 30%)</td>
<td>10%</td>
<td>50% (mech. 15%, chem. 35%)</td>
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<tr>
<td>Orth et al. 2022</td>
<td>Plastic Sector 2020–2050 (EU)</td>
<td>4%</td>
<td>90% renewable carbon (authors use the term &quot;zirkuläre Rohstoffe&quot;), 10% fossil carbon</td>
<td></td>
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<tr>
<td>Meys et al. 2021 (Carbon Minds)</td>
<td>Chemical Industry (cracker) 2050</td>
<td>ca. 4%</td>
<td>21%</td>
<td>33%</td>
<td>45% (20% mech. 25% chem.)</td>
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</table>
| CEFIC 2021, iC2050            | Chemical Industry (cracker) 2050 (EU 27)       | high electr.: 2.2%  
circ.: 1.1% 
sust. biomass: 2.3%  
CO₂ capt.: 1.1% (4 scenarios based on feedstock demand) | high electr.: 27% (60% fossil)  
circ.: 17% (54% fossil)  
sust. biomass: 35% (53% fossil)  
CO₂ capt.: 1% (88% fossil) | high electr.: 13% (60% fossil)  
circ.: 29% (54% fossil)  
sust. biomass: 12% (53% fossil)  
CO₂ capt.: 11% (88% fossil) | low: 35% (mech. 27%, chem. 8%)  
medium: 48% (mech. 31%, chem. 17%)  
high: 65% (mech. 33%, chem. 32%) |
| Material Economics 2019       | Plastic Sector 2050 (EU)                        | scenarios show lower demand in 2050 because of efficiency | 27 to 33% (three scenarios); bio-based plus CO₂ “at least 38%” | CO₂ as feedstock is covered, but without separated quantification | 25 to 53%²) (three scenarios), max. 62% |

¹) Recycling is here mainly understood as virgin demand reduction, not as a supply option. 3% are the biogenic part only.
²) Sum is below 100%, because there are also shares for “circular economy in major value chains” and different kinds of stream cracking (with and without CCS).
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Shape the Future of the Chemical and Material Industry

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23–25 May 2023 | Siegburg/Cologne

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Thank you for your attention!

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Implementation of the SSbD framework: needs, challenges, opportunities for the SusChem community

AMI2030: Delivering on the Materials Manifesto – what is needed to (re-)gain EU Advanced Materials technology leadership?

Moderators:  Thomas GÖRGEN, Covestro/SusChem Board
Philippe JACQUES, EMIRI/SusChem Board
Implementation of the SSbD framework: needs, challenges, opportunities for the SusChem community

*Moderator:* Thomas GÖRGEN, Covestro/SusChem Board
Panel discussion on Advanced Materials: "Which challenges do advanced materials need to overcome to deliver on the Green Deal targets and EU strategic autonomy?"
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"Which challenges do advanced materials need to overcome to deliver on the Green Deal targets and EU strategic autonomy?"

- Jürgen Tiedje, Head of Unit European Commission Directorate-General for Research and Innovation - Prosperity - Industrial Transformation
- Nicolas Cudré-Mauroux, Chief Technology Officer Solvay
- Katja Loos, Professor for Polymer Science and Applied Chemistry Rijksuniversiteit Groningen
- Fabian Weinhandl, Head of GreenTech solutions at BDI
- Paul Cordfunke, Senior Consultant Lux Research

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Fabian WEINHANDL

Head of GreenTech solutions at BDI
Paul CORDFUNKE

Senior Consultant Lux Research
Closing remarks

J.R. Wünsch, Senior Vice President at BASF SE
Thank you!
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