# The international ecosystem for accelerating the transition to Safe-and-Sustainable-by-design materials, products and processes.

## D4.5 Report on barriers, lessons-learned and incentives

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## Disclaimer



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## Abbreviations and Acronyms

| Abbreviation | Definition |
|---|---|
| 10R framework | Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover |
| ADEME | The French Environment and Energy Management Agency (Agence de la Transition Écologique) |
| AI | Artificial Intelligence |
| AMi2030 | Advanced Materials Initiative 2030 |
| ANSES | Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail |
| BMK | The Austrian Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology |
| BMUV | The German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection |
| CCUS | Carbon Capture, Utilisation, and Storage |
| D | Deliverable |
| DG RTD | The EC Directorate-General for Research and Innovation |
| DoA | Description of the Action |
| EC | European Commission |
| EIC | European Innovation Council |
| ETS | Emissions Trading System |
| EU | European Union |
| FAIR | Findable, Accessible, Interoperable and Reusable |
| HaDEA | European Health and Digital Executive Agency |
| IKEM | Innovation and Chemical Industries in Sweden |
| JRC | Joint Research Centre |
| LCA | Life-Cycle Assessment |
| LCC | Life-Cycle Costing |

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| Abbreviation | Definition |
|---|---|
| M | Month |
| MO | Multi-objective optimization |
| NIC | National Institute of Chemistry |
| NTP | National Technology Platform |
| NAM | New approach methodologies |
| NTP | National Technology Platform |
| NWA | Dutch Research Agenda programme |
| NWO | The Dutch Research Council |
| PARC | Partnerships for the Assessment of Risks from Chemicals |
| PEF | Product environmental footprint |
| PFAS | Polyfluoroalkyl Substances |
| RISE | Research Institutes of Sweden |
| RIVM | The Dutch Ministry of Infrastructure and The National Institute for Public Health and the Environment (RIVM) |
| RRF | Recovery and Resilience Facility |
| RVO | Dutch Enterprise Agency |
| SbD | Safe-By-Design |
| S-LCA | Social Life Cycle Assessment |
| SMEs | Small and medium sized companies |
| SSbD | Safe-and-Sustainable-by-Design |
| SusChem | European Technology Platform for Sustainable Chemistry |
| VC | Value Chain |
| WP | Work Package |

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# 1 Executive Summary

The implementation of Safe and Sustainable-by-Design (SSbD) principles is a critical pathway towards a safer, greener future. This report gives key insights on lessons learned and incentives to drive the SSbD adoption across industries.

**Lessons Learned:**

The report identifies several challenges hindering the widespread adoption of SSbD. Key barriers include:

1. **Limited Awareness:** Small companies, particularly downstream from the chemical industry, lack awareness of SSbD principles.
2. **Framework Applicability:** Existing SSbD frameworks primarily focus on chemical substitution, limiting effectiveness in complex articles.
3. **Resource Constraints:** Many companies, especially smaller ones, lack resources for comprehensive safety and sustainability evaluations.
4. **Confidentiality Concerns:** Confidentiality issues impede information sharing, hindering thorough SSbD assessments.
5. **Circularity and Sustainability:** SSbD frameworks need enhancement in assessing circularity and end-of-life solutions.
6. **Functionality vs. Sustainability Trade-offs:** Balancing functionality with sustainability presents challenges, requiring guidance on trade-offs.
7. **Skills Development:** There's a need to enhance sustainability skills and integrate them into business priorities.
8. **Lack of Common Tools:** A unanimous call exists for the development of common SSbD tools tailored to sector-specific needs.

Strategies to address these challenges include increasing awareness through targeted education, refining frameworks, streamlining evaluations, fostering secure information sharing, integrating circularity assessments, providing guidance on trade-offs, investing in skills development, and developing common SSbD tools.

**Incentives:**

At both European and Member State levels, various incentives need to drive SSbD adoption, and these were looked at on different levels:

1. **European Funding Initiatives:** Horizon Europe provides substantial funding and important projects/partnerships like IRISS, PARC and IAM4EU as well as targeted calls for SSbD research and innovation. However, it can be considered that other

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programmes like Innovation Fund, European Innovation Council also contributes strongly to various dimensions of SSbD.

2. **Member State Engagement:** Countries like Denmark, the Netherlands, Austria, Sweden, and others offer dedicated funding programs and strategic initiatives, even if sometimes it is not directly on the SSbD topic, but rather looking at dimensions in separate ways like sustainability by design, eco design, or safe by design.
3. **Programs and Initiatives:** Funding programs, workshops, and strategies support eco-design, circular economy, and SSbD-specific research and development.
4. **Collaborative Efforts:** Stakeholders collaborate to develop research agendas, educational materials, and SSbD-specific roadmaps.

Overall, these incentives aim to drive innovation, collaboration, and environmental stewardship by integrating safety and sustainability considerations into product, materials and processes design and development processes.

In conclusion, addressing the challenges and leveraging incentives outlined in this report is crucial for advancing SSbD principles across industries. By fostering collaboration, increasing awareness, refining frameworks, and investing further in research and development, stakeholders can unlock the full potential of SSbD, driving innovation towards a safer, greener, and more sustainable future.

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# 2 Introduction and objectives

This report takes part of the activities within work package 4 (WP4), task 4.4 "*Uptake of the SSbD approach by the value chains"* and more specifically subtask 4.4.2: Analysis on the progress and identification of incentives and support schemes.

The first objective of this task, as described in the Description of the Action (DoA) of IRISS project, was to first gather information from their members on the barriers and challenges for the uptake of the SSbD criteria. Furthermore, success cases of their members and the lessons-learned were planned to be collected through questionnaires.

The barriers and challenges have been extensively developed in WP2 where the value chains (VCs) have been directly involved *(ref. deliverable D2.1 "Harmonized methodology for gap analysis" from IRISS project).* Moreover success cases or case studies are in preparation by the VCs and feedback and the lessons from applying the EC Joint Research Center (EC JRC) SSbD Framework[1] will be sent to JRC as part of the testing phase[2] of the SSbD framework and will also be used for the development of D4.3: *Gap analysis for SSbD criteria from all value chains* to be delivered by month M28 (postponed from M21 to M28). As a consequence, this report will focus on the lessons learned following the work done by the VCs in WP4 and WP2 relating to SSbD implementation.

The second objective was that Cefic, with the support of SSbD Consulting Europe and the SusChem National Technology Platform (NTPs), including input from the VCs identifies the available incentives for the uptake of SSbD criteria in the respective VCs considering economic and legal aspects.

The activities which are carried out under named "case studies" which are precisely about uptake of SSbD criteria is still in course and will be gathered in D4.3.

In this report, the general incentives at European level and Member State level are described fulfilling the third objective of this deliverable which is the identification of support and funding schemes at the regional, national and European level.

[1] Caldeira, C., Farcal, R., Garmendia Aguirre, I., Mancini, L., Tosches, D., Amelio, A., Rasmussen, K., Rauscher, H., Riego Sintes, J., & Sala, S. (2022). Safe and Sustainable chemicals by design chemicals and materials: Framework for the definition of criteria and evaluation procedure for chemicals and materials. Publications Office of the European Union, Luxembourg, 2022. https://doi.org/doi:10.2760/487955

[2] European Commission. Safe and Sustainable by Design: Test the framework. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/key-enabling-technologies/chemicals-and-advanced-materials/safe-and-sustainable-design_en#test-the-framework (accessed April 2024).

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# 3 Lessons learned

## 3.1 Background

The document titled "Deliverable D2.1 '*Harmonised methodology for gap analysis*'. " represents a significant achievement of the IRISS Task 2.1. This deliverable outlines the discrepancies noted in the existing SSbD methodologies and criteria as mapped out in IRISS WP1, alongside the seven IRISS VCs (Textiles, Construction, Packaging, Energy Materials, Electronics, Automotive, and Fragrances). It also proposes actions to address these gaps.

Key gaps include the need for standardized, universally applicable tools and protocols for SSbD implementation. For Safe-by-Design (SbD), employing new approach methodologies (NAMs) early in material development could elucidate safety impacts while minimizing animal testing, favouring *in silico* and *in vitro* testing methods. The development of unified ontologies for clear communication among stakeholders and digital systems is essential.

The SSbD JRC framework should consider product functionality, durability, and risk assessments early in the design process. Sustainability goals, such as designing durable products with end-of-life solutions and considering energy efficiency during the design process through methods like friction studies and tribology, are crucial.

Furthermore, there's a push for rules on Findable, Accessible, Interoperable and Reusable (FAIR) Data accessibility across VCs to maintain competitive advantage. Simplifying lifecycle assessment (LCA) methods and enhancing them with comprehensive, openly accessible databases is critical. The need for ex-ante LCAs to predict environmental impacts at the initial stages of material development is also highlighted. Impact assessment methodologies, like for example product environmental footprint (PEF) should be integrated with specific product category rules to accurately measure carbon footprints. Lifecycle costing (LCC) evaluations should include the monetization of environmental and social impacts, while Social Life Cycle Assessment (S-LCA) requires further development in analysis protocols and practical applications. The implementation of the 10R framework[3] strategies (i.e. refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover) in different VCs, along with a unified SSbD assessment method, is necessary for further advancement.

Practical education and training on SSbD implementation are also deemed essential for its successful adoption in professional settings.

[3] Potting, J., Hekkert, M. P., Worrell, E., & Hanemaaijer, A. (2017). Circular economy: measuring innovation in the product chain. Policy Report, PBL publication number: 2544, Planbureau voor de Leefomgeving. https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf

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## 3.2 Lessons learned from the 1st period of the project

Additionally, to the WP2 outcomes to date, various discussions during the internal project meetings involving partners and more specifically the VCs, and externally in workshops, key barriers to the implementation of SSbD were identified, especially for small companies and those outside the chemical industry's direct VC. SSbD is an evolving framework intended to integrate safety and sustainability into product design from an early stage. However, numerous challenges hinder its widespread adoption.

A summary of lessons learned from current practices can be listed as following:

- **SSbD awareness and industry reach**

A significant barrier to SSbD adoption is the lack of awareness, particularly within small and medium sized companies (SMEs) that are further downstream from the chemical industry's core activities. These entities often overlook SSbD principles, especially when their operations do not involve direct chemical substitution. Increasing awareness through targeted education and outreach programs is crucial for broadening SSbD implementation.

- **Applicability of the current JRC SSbD framework**

The present SSbD framework is mostly tailored towards chemical substitution rather than the development of complex articles comprising multiple components. This focus limits the framework's effectiveness at the end of the VC, where article production takes place. There is a need for an expanded, adapted SSbD framework that accounts for the complexities of such articles.

- **Resource and innovation constraints**

The process of aligning with SSbD principles is often complex and resource-intensive. Many companies, particularly again smaller ones, lack the necessary resources for comprehensive safety and sustainability evaluations. Moreover, the current cut-off criterion within SSbD can restrict innovative processes. Simplifying evaluations and redefining criteria can facilitate greater innovation while maintaining SSbD goals.

- **Confidentiality and Information Sharing**

Confidentiality issues arise when downstream stakeholders depend on supplier information without full transparency. This lack of open information can prevent the ability to conduct thorough SSbD assessments. Developing a framework and/or tools with the necessary protection for secure information sharing could mitigate this issue and enhance collaboration across the VCs.

- **Design for circularity sustainability**

The SSbD framework is currently weak in assessing circularity, durability, and sustainability. To address this, it must integrate in more comprehensive manner and really measure the longevity and end of life of products, thereby promoting a more circular economy, which is considered a priority aspect by the different VCs.

- **Functionality versus safety and sustainability and trade offs**

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Balancing functionality with sustainability is a complex aspect of innovation. There is a clear need for guidance on making trade-offs, which is vital for companies to navigate the innovation process effectively while adhering to SSbD principles.

- **Skills**

In the journey towards SSbD implementation across the VCs, there are distinct skill-related challenges. Each VC demonstrates strong safety skills, whether in-house or through supplier relations. There's a recognized need to emphasise innovation on functionality and cost-efficiency, while increasingly integrating sustainability considerations.

However, sustainability skills are observed to be less developed, highlighting a demand for increased internal knowledge. The integration of sustainability is not only strategy-dependent but also relies on market demands and the capacity for investment. This underlines the importance of SSbD competencies aligning with business priorities.

Attracting young professionals into industrial research is facilitated when sustainability is emphasized, showing a cultural shift in professional interests towards greener innovation. Furthermore, a fundamental understanding of chemistry and materials science is essential for SSbD, suggesting a baseline educational requirement for many different involved stakeholders.

- **Tools**

There is a unanimous call among all VCs for the development of a common SSbD tool that is finely tuned to the needs and specificities of each sector. This tool would aid in bridging the current skills gap and facilitate a more uniform approach to SSbD implementation.

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# 4 Incentives

This chapter aims at looking at Member State (national) and European incentives which are available for companies and other stakeholder like universities which support SSbD practical application.

## 4.1 European level

The European Union supports the implementation of the SSbD concept through several funding opportunities and initiatives[4], which are part of a broader commitment to encourage innovation towards a green and sustainable industrial transition. These initiatives aim to minimize the impact on health, climate, and the environment during the sourcing, production, use, and end-of-life of chemicals, materials, products, and processes.

### 4.1.1 Horizon Europe

The EU's key funding program for research and innovation, with a budget of EUR 95.5 billion, tackles climate change, helps achieve the United Nations' Sustainable Development Goals, and boosts the EU's competitiveness and growth. It includes specific pillars and clusters focusing on various global challenges and European industrial competitiveness, such as health, culture, creativity, civil security, digital, industry, space, climate, energy, mobility, and food and natural resources (Research and innovation).

A key incentive in Horizon Europe, cluster 4, is actually the IRISS project[5], which aims to connect, synergize, and transform the SSbD community in Europe and globally towards a lifecycle approach. The project focuses on integrating circularity, climate neutrality, functionality, and safety of materials, products, and processes throughout their life cycle. It specifically targets VCs for textiles, construction, electronics, energy, automotive, packaging, and fragrance to meet the EU Green Deal, EU Chemicals Strategy for Sustainability, and United Nations' Sustainable Development Goals. The IRISS project has defined specific objectives and work packages to map and assess state-of-the-art methods and criteria of existing SSbD approaches, identify gaps in knowledge and tools for SSbD, and develop SSbD roadmaps. This project is funded by the EU's Horizon Europe framework programme, with a budget of EUR 4.3 million, of which approximately EUR 3.5 million come from the EU.

Another key European incentive under Horizon Europe is the PARC public-public partnership[6]. It is a 7 years partnership – with a budget of EUR 400 million. It is an initiative where the European Union, prepared with early involvement of Member States and Associated Countries, together with public partners (EU and National Risk Agencies, Universities, Public Research Organisations), commit to jointly support the development and

[4] European Commission. Safe and sustainable by design. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/key-enabling-technologies/chemicals-and-advanced-materials/safe-and-sustainable-design_en (accessed April 2024).
[5] IRISS. About IRISS. https://iriss-ssbd.eu/iriss/about-iriss (accessed April 2024),
[6] PARC. Homepage. https://www.eu-parc.eu/ (accessed April 2024).

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implementation of a programme of research and innovation activities in relation with the assessment of risk from chemicals.

PARC has a work package on SSbD[7] and is developing a toolbox for an exhaustive and practical implementation of the SSbD assessment within the innovation process of an organisation.

The importance of SSbD principles, with a special focus on circularity considerations and fostering of innovation based on circularity and life-cycle thinking principles can also be found in the Advanced Materials Initiative 2030 (AMi2030)[8], one of the drafting initiatives behind a new Public Private Partnership, IAM4EU (Innovative Advanced Materials for the European Union)[9]. The partnership will aim at being a multi-sectoral accelerator for the design, development and uptake of sustainable advanced materials towards a circular economy. Five objectives to be called for under this partnership have been identified for innovative advanced materials: 1) reducing/substituting critical raw materials for more resilience of the advanced materials VCs; 2) saving resources as well in the production process of the advanced materials as during the use phase of the materials themselves; 3) novel functionalities as a core element for innovation in the field of advanced materials; 4) favouring renewable resources; 5) innovative advanced materials that are enabling a circular economy.

Topics that will be covered by IAM4EU calls for research and innovation projects will include, amongst others, integration of the 10R framework[10], SSbD and a life-cycle thinking mindset approach to innovation in correlation with e.g. the European Commission's upcoming Ecodesign for Sustainable Products Regulation[11]. IAM4EU will take up its activity in relation

[7] PARC. Tools & Resources. https://www.eu-parc.eu/thematic-areas/tools-resources/safe-and-sustainable-design-toolbox (accessed April 2024).

[8] AMi2030. https://www.ami2030.eu/ (accessed April 2024).

[9] Cefic. IAM4EU in the spotlight: Pioneering Advanced Materials for Europe's Future. https://cefic.org/media-corner/newsroom/iam4eu-in-the-spotlight-pioneering-advanced-materials-for-europes-future/ (accessed April 2024).

[10] Vermeulen, W., Reike, D. & Witjes, S. (2019). Circular Economy 3.0 – Solving confusion around new conceptions of circularity by synthesising and re-organising the 3R's concept into a 10R hierarchy. *Renewable Matter*, 27. https://www.researchgate.net/publication/335602859_Circular_Economy_30_-_Solving_confusion_around_new_conceptions_of_circularity_by_synthesising_and_re-organising_the_3R's_concept_into_a_10R_hierarchy

[11] European Commission. Ecodesign for Sustainable Products Regulation. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en (accessed 2024).

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to the work programme 2025 of Horizon Europe[12,13].The Horizon Europe program has issued calls that specifically mention "SSbD" within its work programmes for 2023 and 2024, focusing on the development of chemicals and materials under this initiative.

For the year 2024, the call **HORIZON-CL4-2024-RESILIENCE-01-24** is aimed at the **development of SSbD alternatives**[14].

The calls for 2023 include[15]:

- **HORIZON-CL4-2023-RESILIENCE-01-21**: "Innovative methods for safety and sustainability assessments of chemicals and materials".
- **HORIZON-CL4-2023-RESILIENCE-01-22**: "Integrated approach for impact assessment of safe and sustainable chemicals and materials".
- **HORIZON-CL4-2023-RESILIENCE-01-23**: "Computational models for the development of safe and sustainable by design chemicals and materials".

These calls align with the broader objectives of the Horizon Europe program for 2023-2024, emphasizing climate action, digital transformation, and the transition towards a safe, secure, and resilient Europe. The program seeks to support innovation that addresses key societal challenges and contributes to the EU's strategic priorities, including the sustainability and safety of chemicals and materials[16].

### 4.1.2 Examples of Horizon Europe projects

Examples of projects currently running incentivize for example, the restriction of use of Per- and Polyfluoroalkyl Substances (PFAS), which are persistent, bio-accumulative, and toxic synthetic chemicals. Those projects are developing PFAS-free coating solutions through SSbD alternatives. These projects are founded on the use of renewable and bio-based materials and leverage predictive models and computational tools.

[12] European Commission (2024). Communication from the Commission to the European Parliament, the Council, the European economic and social Committee and the Committee of the regions. Advanced Materials for Industrial Leadership. COM(2024) 98 final, Strasbourg, 27.2.2024. https://research-and-innovation.ec.europa.eu/document/download/0fcf06ea-c242-44a6-b2cb-daed39584996_en?filename=com_2024_98_1_en_act_part1.pdf

[13] European Commission. Chemicals and advanced materials. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/key-enabling-technologies/chemicals-and-advanced-materials_en (accessed April 2024).

[14] HaDEA. Horizon Europe Calls 2024 – Destination 2. Increased autonomy in key strategic value chains for resilient industry. https://hadea.ec.europa.eu/calls-proposals/horizon-europe-calls-2024-destination-2-increased-autonomy-key-strategic-value-chains-resilient-0_en (accessed April 2024).

[15] HaDEA. Horizon Europe Calls 2023 – Destination 2. Increased autonomy in key strategic value chains for resilient industry. https://hadea.ec.europa.eu/calls-proposals/horizon-europe-calls-2023-destination-2-increased-autonomy-key-strategic-value-chains-resilient_en (accessed April 2024).

[16] HaDEA. The 2023-2024 work programme of Horizon Europe is out! https://hadea.ec.europa.eu/news/2023-2024-work-programme-horizon-europe-out-2022-12-06_en (accessed April 2024).

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BIO-SUSHY[17] is creating a complete operating framework for the development of innovative repellent organic and hybrid coatings to challenge widespread and polluting PFAS. These coatings, with both hydrophobic and oleophobic properties, are obtained from acknowledged processing technologies, i.e., bio-based thermoplastic powder and hybrid sol-gel. These sustainable and PFAS-free coatings will be validated to cover a wide range of applications and fields, such as textiles, glass, cosmetics, and food packaging.

PROPLANET[18] designs and optimises three innovative coatings for industrial sectors: textile, food-packaging, and glass. All coatings are designed based on SSbD concepts and optimised with mathematical computational tools such as first-principles-based models, in silico models, environmental fate models, and sustainability assessment. A tool based on data-driven algorithms and multi-objective optimization (MO) promotes the integration of the novel coatings on different applications, supporting their route to market, operating at different conditions, and following an Eco-design thinking.

TORNADO[19] project aims to contribute to the transition to a safe circular economy by developing two new PFAS free organic and hybrid free-toxic coatings with water and oil repellence following SSbD criteria. The two coatings will be validated in industrially relevant environments to obtain a performance at least identical to PFAS coatings in terms of water and oil repellence and tested according to the main textile, packaging and kitchenware specifications and requirements.

ZeroF[20] develops SSbD coating alternatives to replace PFAS compounds in food packaging and upholstery textiles VCs. The coatings have limited water absorption, high oil/grease resistance for packaging and high water and oil repellence for textiles. PFAS are replaced by two chemistries, cellulose fatty acid esters for packaging and silane-based organic-inorganic hybrids for textiles. The project includes three work streams: food packaging, upholstery textiles and SSbD analysis.

### 4.1.3 Other programmes

Other initiatives do have some contribution to Safe and Sustainable Chemicals and Materials, even if they don' specify SSbD. It can be considered that a wide range of funding opportunities support the implementation of the "SSbD" concept through various programs, each aimed at fostering innovation and sustainability across different sectors and disciplines:

- **Connecting Europe Facility:** This program supports the development of high-performing, sustainable, and efficiently interconnected trans-European networks in the fields of energy, transport, and digital services[21].
- **European Green Deal:** Within Horizon Europe, there are green missions aimed at addressing some of Europe's greatest challenges, including adaptation to climate

[17] BIO-SUSHY. Homepage. https://www.bio-sushy.eu/ (accessed April 2024).
[18] PROPLANET. Homepage. https://www.proplanet-project.eu/ (accessed April 2024).
[19] TORNADO. Homepage. https://tornado-project.eu/ (accessed April 2024).
[20] ZeroF. Homepage. https://www.zerof.eu/ (accessed April 2024).
[21] European Commission. Connecting Europe Facility.
https://cinea.ec.europa.eu/programmes/connecting-europe-facility_en (accessed April 2024).

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change, climate-neutral and smart cities, soil health, and restoring oceans and waters. These missions are designed to deliver concrete results by 2030, inspiring confidence in the transformations ahead[22].

- **European Innovation Council (EIC)** 2024 Work Programme: With a budget of over EUR 1.2 billion, this program supports the development and scaling up of "deep tech" innovations in SMEs and startups. Areas of focus include generative Artificial Intelligence (AI), space, critical raw materials, semiconductors, and quantum technologies. The EIC also provides Business Acceleration Services to support projects with coaching, mentoring, and partnering opportunities[23].
- **Horizon Europe for Energy Supply:** A call for proposals with a total indicative budget of EUR 246 million is available for projects in sustainable, secure, and competitive energy supply. This includes renewable energy, energy systems, grids, and storage, as well as Carbon Capture, Utilisation, and Storage (CCUS)[24].
- **Additionally, the Innovation Fund** is a significant funding opportunity that supports innovative clean tech projects contributing to greenhouse gas emission reductions. It is financed by revenues from the auctioning of allowances from the EU's Emissions Trading System (ETS) and aims to finance the demonstration and commercialization of innovative low-carbon technologies. The Fund has granted EUR 1.8 billion to 16 innovative projects that cover ground-breaking technologies from green hydrogen and synthetic sustainable aviation fuel to methanol production from renewable hydrogen[25,26].

Each of these programs and initiatives is part of the EU's broader strategy to drive sustainable and inclusive growth across the continent, supporting the transition towards a greener, more resilient, and digital Europe.

## 4.2 Member State level

The level of maturity on the SSbD concept varies according to each member state.

In this chapter we will give a selection of countries which have known SSbD related incentives. This selection has been gathered through the SusChem NTPs partners and IRISS

[22] European Commission, European Green Deal, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (accessed April 2024).
[23] European Innovation Council. Homepage. https://eic.ec.europa.eu/index_en (accessed April 2024).
[24] CINEA. Horizon Europe: EUR 246 million available for projects in sustainable, secure and competitive energy supply. https://cinea.ec.europa.eu/funding-opportunities/calls-proposals/horizon-europe-eur-246-million-available-projects-sustainable-secure-and-competitive-energy-supply_en (accessed April 2024).
[25] CINEA. How the Innovation Fund is contributing 17ot he EU Green Deal. https://cinea.ec.europa.eu/news-events/news/how-innovation-fund-contributing-eu-green-deal-2022-06-30_en (accessed April 2024).
[26] European Commission. Innovation Fund: grant agreements signed with further 16 innovative large-scale projects. https://climate.ec.europa.eu/news-your-voice/news/innovation-fund-grant-agreements-signed-further-16-innovative-large-scale-projects-2023-01-19_en (accessed April 2024).

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project partners. The countries which are not mentioned don't have any specific direct SSbD initiatives to date.

On a general basis, the European Green Deal and twin transition implementation are supported at national level by the Recovery and Resilience Facility (RRF) which focuses on broad goals like green transition, digital transformation, and economic resilience across EU member states. It supports investments in clean energy, digital education, and health system improvements, among others. The total fund amounts EUR 723.8 billion in loans and grants.

The national recovery and resilience plans of individual EU countries outline the specific reforms and investments planned. These plans often focus on sustainability and could contain principles such as SSbD developments, especially in sectors like clean energy and sustainable manufacturing[27].

It is noted that the most active countries are Netherlands, Austria, and Denmark, in the sense that they have direct initiatives on SSbD. The other countries deal with Circular economy (circular by design), safe by design, but not with "SSbD" in a holistic way, as defined by the 2022 EC Recommendation of the SSbD Framework[28].

However, some countries like France, Germany, Spain, Belgium, Finland dedicate important funding to sustainability including circularity, ecodesign. And it is important to note that all EU countries dedicate resource to the pathway to net zero emissions, which contributes highly to an SSbD assessment.

### 4.2.1 Denmark

Denmark prioritizes sustainability and safety by design. Funding opportunities from agencies like the Danish Environmental Protection Agency and the Danish Business Authority often support projects focused on eco-design and sustainable innovation.

There was a specific workshop on SSbD principles organized by the ministry of Environment, incl. Chemistry, Circular Economy, Sustainable environment, and production organised in 2023. This followed an initiative, request from the Danish parliament asking for Political priorities within chemicals regulation, including topics like responsible green chemistry in a sustainable world, a toxic-free environment, safe food, safe Danish workplaces and safe consumers, a solid scientific foundation, enforcement. This was reported during the EC Directorate-General for Research and Innovation (DG RTD) workshop 7th and 8th of December 2023.

[27] European Commission. Recovery and Resilience Facility. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/recovery-and-resilience-facility_en (accessed April 2024).

[28] European Commission. (2022). Commission Recommendation of 8.12.2022 establishing a European assessment framework for safe and sustainable by design chemicals and materials. C(2022) 8854 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022H2510

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### 4.2.2 Netherlands

The Netherlands places a significant emphasis on sustainability and innovation. Entities like the Dutch Ministry of Infrastructure and Water Management and the Dutch Enterprise Agency (RVO) often offer funding and support for initiatives that promote SSbD practices:

The Dutch Ministry of Infrastructure and The National Institute for Public Health and the Environment (RIVM) have a SSbD program focusing on chemicals, nanotechnology, and biotechnology[29]. In this program, research and educational material is developed to support SSbD[30,31,32,33].

Within the Dutch Research Agenda (NWA) programme 'Towards a practical Safe-by-Design approach for chemical products and processes', three consortia will research and develop an applicable Safe-by-Design approach. A total of about EUR 2.7 million has been awarded for this research. This research programme is a collaboration between the Ministry of Infrastructure and Water Management, the Ministry of Social Affairs and Employment and NOW[34].

### 4.2.3 Austria

Austria is very active in the SSbD field (the Austrian government participated in the 07/08 December 2023 DG RTD workshop). In that regard, a SSbD-specific Roadmap has been developed for the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). Based on the efforts of the Austrian Community (including SusChem-AT efforts), this should evolve towards incentive/specific funding dedicated to further development SSbD-competences as well as support of SSbD-implementation by the Austrian government.

One other notable initiative that promotes SSbD principles is the "Eco-Innovation Programme" (Öko-Innovationsprogramm[35]) supported by (BMK).

The Eco-Innovation Programme aims to support projects that drive eco-friendly innovation and sustainable development across various sectors of the economy. It provides financial support, technical assistance, and networking opportunities to businesses, research

[29] Safe-by.Design. https://www.safe-by-design-nl.nl/home+english/about+safe-by-design/default.aspx (accessed April 2024):
[30] Education and Safe by Design. https://biotechnologie.rivm.nl/safe-by-design (accessed April 2024).
[31] Information Map 'Safe and Sustainable by Design' of chemicals and materials. https://www.government.nl/documents/publications/2022/12/19/information-map-safe-and-sustainable-by-design-of-chemicals-and-materials (accessed April 2024).
[32] Safety Framework Biotechnology. https://biotechnologie.rivm.nl/safe-by-design/guidances/safety-framework-biotechnology (accessed April 2024).
[33] Companies. https://www.safe-by-design-nl.nl/home+english/documents/companies+documents/default.aspx (accessed April 2024).
[34] NWO (2022). Three consortia awarded funding for applicable Safe-by-Design principles for chemical products and processes. https://www.nwo.nl/en/news/three-consortia-awarded-funding-applicable-safe-design-principles-chemical-products-and
[35] BMK. Öko-Check. https://www.bmk.gv.at/themen/innovation/FTI-Themen/IWI/oekoscheck.html (accessed April 2024).

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institutions, and other organizations involved in developing and implementing innovative solutions with a focus on environmental sustainability.

Businesses interested in integrating SSbD principles into their operations can explore funding opportunities and resources provided by the Eco-Innovation Programme. This initiative aligns with Austria's broader commitment to environmental sustainability, innovation, and economic competitiveness.

### 4.2.4 Sweden

Sweden has got no specific SSbD projects up to date. However, they have numerous incentives contributing to SSbD implementation, where the following initiatives can be highlighted:

- **Vinnova**[36]

This project is dedicated to circularity by design which is an important pillar of SSbD[37].

- **Mistra Challenge**[38]

The Mistra challenge is dedicated to Reduced resource consumption and an accelerated circular economy.

The different calls in the resource area can be found in Re:source[39]. The Mistrasafe project[40] concentrates on Safe by design.

- **Fossil free Sweden**

Fossil free Sweden (national initiative to make Sweden the first fossil-free welfare nation in the world)[41]. There are already roadmaps developed for 23 sectors and the chemical industry started their work with a hearing in March. It is led by IKEM and the Pharmaceutical industry[42,43]. They also have a ”Swedish center for chemical substitution” as part of RISE Research institutes[44], which include a plan for SSbD education.

### 4.2.5 Slovenia and Balkans

The National Institute of Chemistry (NIC) has carried out numerous activities aimed at promoting SSbD and the IRISS project in the Balkan region.

[36] Vinnova. Homepage. www.vinnova.se/en/ (accessed April 2024).
[37] Vinnova. Circularity - FFI - spring 2024. https://www.vinnova.se/en/calls-for-proposals/utlysning-2022-00048/circularity-ffi-spring-2024/ (accessed April 2024).
[38] Mistra. Mistra Utmana (“Mistra Challenge”). https://mistra.org/utlysningar/mistra-utmana/#eng (accessed April 2024).
[39] RE:SOURCE. Utlysningar. https://resource-sip.se/utlysningar/ (accessed April 2024).
[40] IVL. Mistra SafeChem. https://www.ivl.se/projekt/mistra-safechem.html (accessed April 2024).
[41] Fossil Free Sweden. Homepage. https://fossilfrittsverige.se/en/start-english/ (accessed April 2024).
[42] Lif. The research-based pharmaceutical industry. https://www.lif.se/en/ (accessed April 2024).
[43] Fossil Free Sweden. Hearing: Chemical industry develops Fossil Free Sweden roadmap. https://fossilfrittsverige.se/event/hearing-kemiindustrin-tar-fram-fardplan-inom-fossilfritt-sverige/ (accessed April 2024).
[44] RISE. Homepage. https://www.ri.se/en (accessed April 2024).

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They have mapped out relevant industry stakeholders from the Balkans to act as promotors of the SSbD in their countries as well as through their networks. We have prepared a letter to inform them of the IRISS project and its expected contribution to the industry. In 2024, we have sent the information promoting IRISS to 75 addresses in Slovenia and the Balkan region.

In Slovenia, there is currently only one initiative in the field of SSbD at the national level besides SusChem and IRISS. It is implemented by the Chamber of Commerce and Industry of Slovenia within the framework of the Chemical Industry Association.

### 4.2.6 Spain

In Spain, one significant initiative that promotes SSbD principles is the "Circular Economy Strategy" (Estrategia Española de Economía Circular), supported by the Spanish Ministry for the Ecological Transition and the Demographic Challenge (Ministerio para la Transición Ecológica y el Reto Demográfico)[45].

The Circular Economy Strategy aims to transition Spain towards a more sustainable and circular economy by promoting eco-design, resource efficiency, waste prevention, and recycling. It provides a framework for government action, collaboration with stakeholders, and the implementation of measures to drive the circular economy transition across various.

Businesses interested in integrating SSbD principles into their operations can explore funding opportunities and resources provided by the Circular Economy Strategy. This initiative aligns with Spain's broader commitment to environmental sustainability, resource efficiency, and the transition towards a circular economy.

### 4.2.7 Germany

In Germany, the most significant initiative that promotes SSbD principles is the "Environmental Innovation Programme" (Umweltinnovationsprogramm[46]) supported by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV - Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz). The Environmental Innovation Programme aims to foster innovation and entrepreneurship while addressing environmental challenges. It provides funding and support to projects that develop innovative solutions to environmental problems, including those related to SSbD. Through this program, businesses, research institutions, and other organizations can access financial assistance, technical expertise, and networking opportunities to develop and implement environmentally friendly technologies and practices. Projects supported by the Environmental Innovation Programme often focus on areas such as resource efficiency, waste reduction, pollution prevention, and sustainable product design.

[45] Ministerio para la Transición Ecológica y el Reto Demográfico. Estrategia Española de Economía Circular y Planes de Acción. https://www.miteco.gob.es/en/calidad-y-evaluacion-ambiental/temas/economia-circular/estrategia.html (accessed April 2024).

[46] Umweltinnovationsprogramm. https://www.umweltinnovationsprogramm.de/ (accessed April 2024).

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### 4.2.8 France

In France, one initiative that promotes SSbD principles is the "ADEME Design for Environment" program. ADEME, the French Environment and Energy Management Agency (Agence de la Transition Écologique), plays a crucial role in supporting projects that focus on eco-design and sustainable development.

The ADEME Design for Environment program aims to encourage businesses to integrate environmental considerations into the design phase of their products and services. It provides funding and support to projects that prioritize eco-design, life cycle assessment, and the reduction of environmental impacts throughout the product life cycle.

Additionally ANSES, the “agence nationale de sécurité sanitaire de l’alimentation, de l’environnement et du travail” coordinates the European Public-Public Partnership for the Chemicals risk assessment, also mentioned above in the European level, as it is 50% financed by the EU and 50% by the member States[47].

[47] ANSES. European Partnership f22or the Assessment of Risks from Chemicals (PARC). https://www.anses.fr/en/content/european-partnership-assessment-risks-chemicals-parc (accessed April 2024).

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# 5 Conclusion

In conclusion, following Deliverable D2.1 establishing a harmonized methodology for SSbD gap analysis where key gaps have been identified, ranging from the necessity for standardized tools and protocols to the key requirement of integration of sustainability considerations into product design. Beside the report key lessons learned from the VCs discussions are highlighted in this report.

Lessons learned from first phase of the project highlight the multifaceted challenges hindering widespread SSbD adoption. These include issues of awareness, applicability of the JRC SSbD framework, resource constraints, confidentiality concerns, circularity and sustainability, trade-offs between functionality and sustainability, skills development, and the need for common SSbD tools tailored to diverse sectors.

Addressing these challenges demands collaborative efforts across stakeholders, including policymakers, researchers, industry players, and educational institutions. Strategies such as targeted education and outreach programs, the development of adapted SSbD frameworks, simplification of evaluation processes, fostering secure information sharing, enhancing circularity assessments, and providing guidance on trade-offs are essential for advancing SSbD implementation.

Additionally, fostering a culture of sustainability within the workforce, attracting young professionals with a focus on green innovation, and investing in educational initiatives to build foundational knowledge in chemistry and materials science are crucial steps toward realizing the full potential of SSbD.

As the project moves forward, it is crucial to remain agile and responsive to evolving challenges and opportunities, leveraging insights gained from past experiences to drive continuous improvement in SSbD methodologies and practices. Ultimately, the successful adoption of SSbD principles promises not only enhanced safety and sustainability in product design but also a transformative shift toward a more resilient and environmentally conscious industrial landscape.

In order to achieve this transformation, incentives at both the European and Member State levels supporting the adoption of SSbD principles, fostering innovation and sustainability across industries were listed.

At the European level, the Horizon Europe program stands as a cornerstone, offering substantial funding opportunities to support research and innovation endeavours aligned with SSbD goals. Initiatives such as the IRISS project within Horizon Europe exemplify concerted efforts to integrate circularity, climate neutrality, and safety into materials, products, and processes across various VCs. Two other initiatives are also a pillar to the SSbD integration in Innovation, PARC and IAM4EU.

Moreover, targeted calls for proposals underscore the EU's commitment to advancing SSbD through specific research areas, such as the development of safe alternatives to hazardous substances (like for example PFAS).

Meanwhile, Member States like Denmark, the Netherlands, Austria, Sweden, Slovenia, Spain, Germany, and France demonstrate proactive engagement in promoting SSbD

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principles through dedicated funding programs, workshops, and strategic initiatives (sometimes in an indirect manner). These efforts encompass a broad spectrum of activities, including research and educational support, eco-design programs, circular economy strategies, and partnerships with industry stakeholders.

The impact of these incentives extends beyond financial support, fostering a culture of innovation, collaboration, and environmental stewardship. By incentivizing the integration of safety and sustainability considerations into product design and development processes, these initiatives pave the way for a more resilient, resource-efficient, and environmentally conscious future.

As SSbD continues to gain momentum as a guiding framework for innovation, the alignment of incentives at both the European and national levels will be essential to accelerate progress towards a more sustainable and prosperous society. Through collaborative efforts and strategic investments, stakeholders across the public and private sectors can collectively drive transformative change and realize the full potential of SSbD in shaping a safer, greener, and more sustainable world.

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