European Commission

Transition Pathway for the Chemical Industry

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EXECUTIVE SUMMARY

The 2020 industrial strategy[1] included a list of actions to support the green and digital (twin) transition of EU industry. However, the COVID-19 pandemic affected the speed and scale of this twin transition. To address this disruption, in the **updated 2021 industrial strategy, the Commission proposed a series of transition pathways** to be developed jointly with EU Member States, industry and other stakeholders. These pathways identify the actions needed to achieve the twin transition, giving a better understanding of the scale, benefits and conditions required. A transition that will also strengthen resilience of the industry largely affected by the Russian war of aggression against Ukraine.

In the spring of 2022, the Commission launched the 'co-development' process for the **transition pathway for the European chemical industry, along with EU Member States, the chemical industry itself, social partners, NGOs and academia**. The outcome of this process is a group of topics and actions to be implemented by each of the involved actors. These most relevant ones are presented as a **roadmap** composed of:

1. An **action-oriented** component grouping the topics under three cross-cutting themes: collaboration for innovation; clean energy supply; and feedstock diversification. These actions are expected to contribute towards the transition and are set against a timeline.
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.

By implementing the actions identified under each topic, the chemical sector is expected to succeed in its twin transition and improve its own resilience, sustainability and 'circularity' (i.e. its functioning in line with the principles of the circular economy), in line with the European Green Deal.

The co-implementation of the transition pathway for the chemical industry will be the next step. This entails disseminating the pathway to all relevant stakeholders, who would then present their commitments specifying the actions and topics to which they will contribute to. The proposals in the final chapter will be discussed and agreed on during the co-implementation process expected to start in spring 2023.

[1] COM(2021) 350 final. Updating the 2020 New Industrial Strategy: building a stronger Single Market for Europe's recovery https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:350:FIN.

I/ INTRODUCTION

The chemical sector has a strategic role in the European economy. Most goods that are manufactured in Europe rely on chemicals for a wide range of various functions. Chemicals are at the heart of Europe's major value chains, including pharmaceuticals, electronics, batteries for electric vehicles, construction materials, etc. The chemical value chain is typically made up of: (i) chemicals producers; (ii) mixture manufacturers; and (iii) producers of articles. Each of these actors in the chemical supply chain has their own needs and will make their own contributions to the future objectives of the green and digital transition of EU industry and its achievement of the twin transition. It has a major focus on producers of chemicals.

The twin transition covers several dimensions for the EU chemical industry: a 'toxic-free' environment, climate neutrality, circularity (the green transition), and digitalisation (the digital transition). All these dimensions must be addressed to support the resilience of the chemical industry[2].

The EU-27 is the second largest chemicals producer in the world, with EUR 499 billion in sales in 2020. The chemical industry is also the fourth largest industry in the EU, accounting for around 7% of manufacturing output by turnover[3]. The industry directly employs 1.2 million highly skilled workers and supports 3.6 million jobs indirectly. It also supports a further 19 million jobs across all other value supply chains in the EU[4]. The EU chemical industry has 67% greater labour productivity than the average for the manufacturing sector.

Nevertheless, the chemical industry is the third emitter of carbon dioxide (CO_2) emissions in the EU (925Mt CO_2 in 2021[5]), behind only the cement and iron/steel industry. As reported by the International Energy Agency (IEA), this is largely because around half of the chemical subsector's energy input is consumed as feedstock – fuel used as a raw material input rather than as a source of energy. Immediate emission reductions are therefore necessary, as highlighted by the latest Intergovernmental Panel on Climate Change's (IPCC's) contribution to the 6th Assessment Report[6]. The IEA's 'net zero' emission scenario by 2050[7] relies on a clear reduction in CO_2 emissions from primary chemicals production[8].

In this regard, the EU chemical industry has already made progress. Despite an increase in production of more than 47% since 1990, greenhouse-gas (GHG) emissions from EU-27 chemical production have decreased by 54% in comparison to 1990 levels. Over the same period, energy consumption in the EU-27's chemical industry has fallen by 21%. **The 2030 and 2050 legally-binding EU climate targets represent the next important step for the chemical industry's emission-reduction efforts, as part of the climate component of the Green Deal.**

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[2] See https://research-and-innovation.ec.europa.eu/research-area/industry/industry-50_en.

[3] CEFIC, 2022. The European chemical industry: a vital part of Europe's future. Facts & Figures 2022.

[4] https://ec.europa.eu/growth/sectors/chemicals_en.

[5] IEA Tracking Report, September 2022: https://www.iea.org/reports/chemicals.

[6] IPCC, 2021. Sixth Assessment Report. https://www.ipcc.ch/assessment-report/ar6/.

[7] IEA Report, Net Zero Emissions by 2050 Scenario (NZE) – World Energy Model.

[8] Primary chemicals are substances obtained in its compounds in the natural state or by intensive manufacturing processes requiring massive amounts of fossil energy.

In 2020, the Commission adopted the Chemicals Strategy for Sustainability (CSS)[9], which '*strives for a toxic-free environment, where chemicals are produced and used in a way that maximises their contribution to society including achieving the green and digital transition, while avoiding harm to the planet and to current and future generations*'. The strategy identifies initiatives to support the transition, including the promotion of toxic-free material cycles and 'clean' recycling.

The EU chemical industry's investment and innovative capacity will be crucial to achieving the goals of the CSS to: (i) provide chemicals and materials that are safe and sustainable by design; and (ii) offer new ways to produce chemicals and materials. It has been reported that the chemical industry is the second largest R&I investor in the chemical industry globally, with EUR 9.4 billion invested every year[10]. This investment and innovation will support the twin transition of our economy and society. The chemical industry will also play a central role in achieving a circular economy in many value chains.

Given its size and strategic relevance, the chemical industry is therefore **at the centre of the European Green Deal** and is a major contributor to achieving its ambition and objectives. Furthermore, the digital transformation is an enabling opportunity for the industry to meet the above objectives, while retaining its competitiveness and keeping pace with societal developments[11].

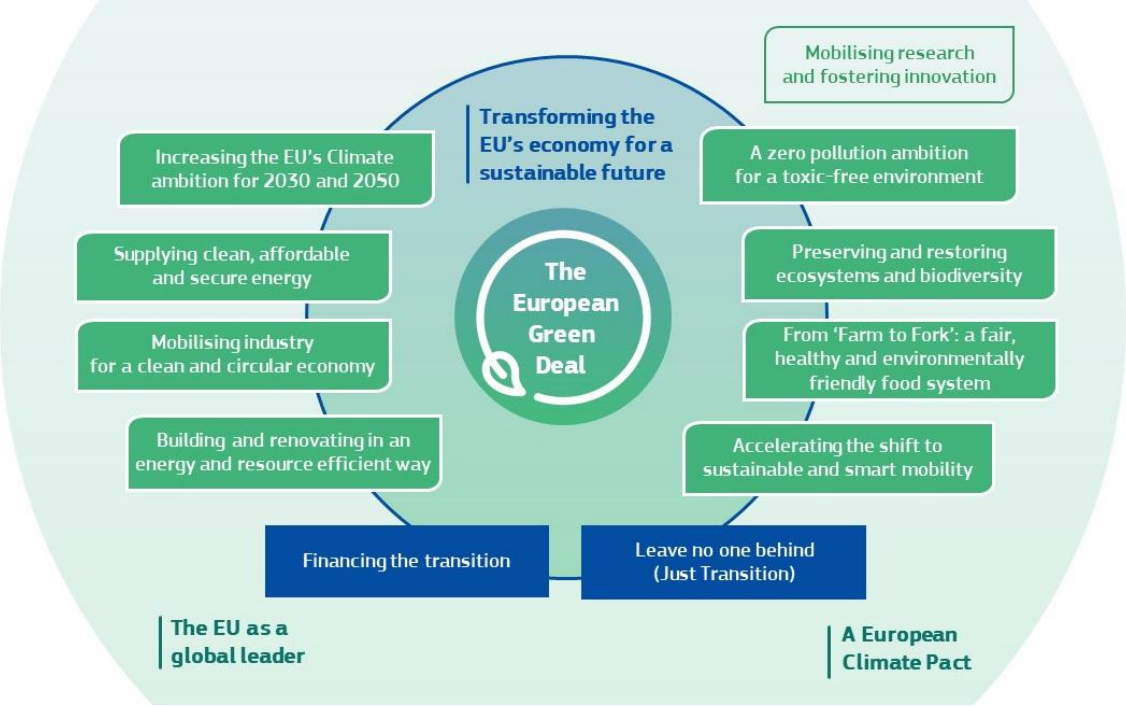

Figure 1 - The European Green Deal elements, including its ambition and objectives

[9] COM (2022) 667 final. Chemicals Strategy for Sustainability Towards a Toxic-Free Environment https://europa.eu/!Vt94Yr.

[10] OECD and Cefic Chemdata International.

[11] See Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme 2030, *OJ L 323, 19.12.2022, p. 4–26,* and in particular the digitalization of business.

The chemical industry clearly understands that it needs to do more and is greatly determined to be at the forefront of the necessary transformative process required by the twin transition. However, the industry stresses that this journey of transformation depend on its ability to stay competitive and to attract global investment.

Other relevant players in the EU's economy that have a crucial role are small and medium-sized enterprises (SMEs), which constitute 96% of European chemical companies[12]. SMEs are present at every level of a chemical supply chain. These companies have diverse roles related to chemicals, and they include manufacturers of raw materials, formulators, distributors, and users of chemicals. SMEs employ two thirds of the EU's workforce and account for 55% of added value in the EU. Furthermore, SMEs play an important part in the EU's vocational system by providing many young people with the opportunity to learn a profession. SMEs are therefore an integral part of the twin transition and resilience of the industry.

The EU chemicals industry is highly integrated into many complex international value chains that are sensitive to the geopolitical context and its sudden developments, such as the Russian war of aggression against Ukraine which started in February 2022. The new Temporary Crisis Framework for State Aid adopted by the Commission on 23 March 2022 includes the chemicals industry among the sectors and sub-sectors that are 'particularly affected' by the war. Although it is difficult to predict the longer-term impact of the war on the EU economy, its initial effects are already visible: accelerated inflation; more fragile supply chains with potential disruptions to supplies of fossil feedstocks and energy sources; temporary curtailment of the operation of chemicals plants; and a drastically weakened outlook for growth, as reported by the industry. Chemical manufacturing, using natural gas as fuel and feedstock is under unprecedented economic pressure, raising fundamental questions about the medium/long-term prospects for energy-intensive manufacturing in Europe.

The current crisis therefore brings into closer focus the objective for resilience set by the updated EU industrial strategy[13]. This strategy emphasised the benefit of increasing the resilience of the chemical industry, i.e. its capacity to absorb external shocks due to a fragile geopolitical situation and a challenging competitive environment, with surging prices of energy and raw materials. It includes a list of actions to support the green and digital (twin) transition of EU industry and its resilience, amongst which a series of transition pathways to be developed jointly with EU Member States, industry and other stakeholders. These pathways identify the actions needed to achieve the twin transition, giving a better understanding of the scale, benefits and conditions required. A transition that will also strengthen resilience of the industry.

This report presents high-level transition pathway for the chemical industry to achieve the twin transition and its resilience. The outcome of this pathway is a three-part roadmap. The roadmap is the result of a co-creation process with stakeholders who discussed with the Commission each of the building blocks that make up the transition pathway structure developed by the Industrial Forum[14]. In addition, the

[12] Cefic, 2018. Economic Outlook (July-2018).

[13] COM(2020) 102 final. A New Industrial Strategy for Europe https://europa.eu/!ghHBCV.

[14] Industrial Forum, 2022. Blueprint for the development of transition pathways.

stakeholders considered recommendations made by the High-Level Roundtable on the Chemical Strategy for Sustainability[15]. For each building block, the stakeholders identified a series of actions and initiatives that would contribute to the achievement of the twin transition and the resilience of the chemical industry. Each action also specified the timeframe for implementation as well as the main actors responsible for implementation. For example, actions being coordinated by EU institutions refer to initiatives and proposals already announced in official Commission documents that were then clustered by topics and integrated into an indicative timeline. This gave direction to some major aspects that require sequencing as part of a co-implementation process (the sequencing is presented in the final chapter).

This transition pathway and the resulting roadmap have been developed as **part of the transition pathway for** the broader group of industries (of which the chemical industry is a part of) categorised as **energy-intensive industries (EIIs)** which refers to the Masterplan for a Competitive Transformation of EU Energy-intensive Industries Enabling a Climate-neutral, Circular Economy by 2050.

[15] See https://environment.ec.europa.eu/news/first-meeting-chemicals-strategy-roundtable-2021-05-05_en.

II/ BUILDING BLOCKS

The aim of this chapter is to describe the actions needed to accelerate the EU chemical industry's green and digital transitions while also making the industry resilient. It follows the structure of the blueprint developed by the Industrial Forum Task Force 2[16] on transition pathways, and is based on a building block approach, where each building block covers a key aspect of the twin transition and the desired move to greater resilience[17]. In addition to the seven building blocks defined by the Industrial Forum, stakeholders agreed to also include a building block on "access to energy and feedstock". The figure below presents them all.

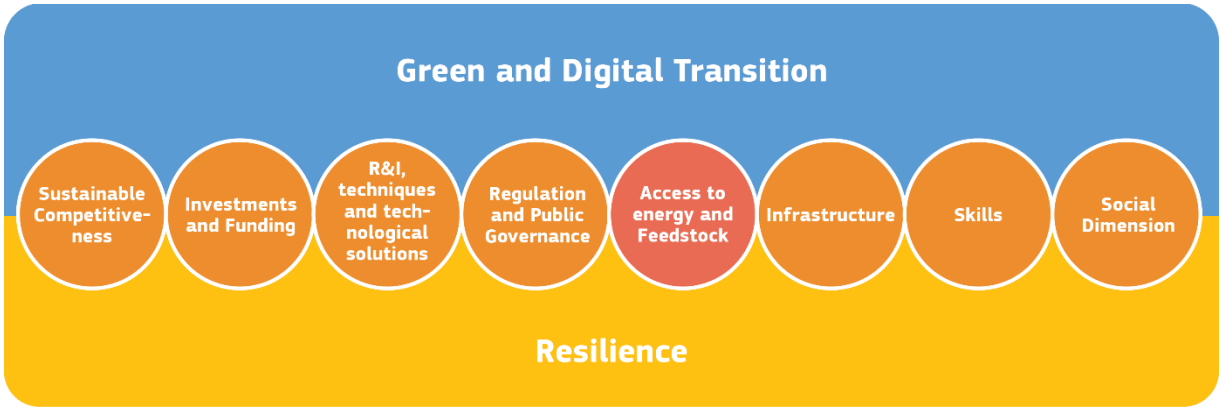

Figure 2 - The 8 building blocks considered to develop the transition pathway for the chemical industry

For each topic listed under the respective building blocks, a list of actions has been identified by stakeholders, together with a timeframe for implementation: short-term, medium-term or long-term. Indicatively, 'S' (i.e. short-term) indicates activities that should start as soon as possible; 'M' indicates activities that should start in the medium-term (i.e. by 2030); while 'L' indicates the long-term, i.e. activities that should be launched and completed by 2050. An overview of topics against a timeline is presented in the following sections.

Each action also mentions the main actor responsible for its implementation, according to the stakeholders participating to the co-development process. 'EU/MS' means that the responsible actor should be either the EU – e.g. via an EU level legislation – or the Member States with a legislative initiative at national level[18]. 'Industry' designates an action that should be coordinated and implemented by industrial actors.

1) SUSTAINABLE COMPETITIVENESS

The EU chemical industry faces unprecedented challenges that include increased international competition; skyrocketing prices of energy and feedstock; a decline in the industry's global competitiveness over recent decades; and a shift of certain activities to outside the EU would

[16] The blueprint matrix including the different building blocks for all ecosystems on transition pathways was developed by the Industrial Forum (Task Force 2 – Support to the development of transition pathways).

[17] The task force identified seven building blocks: sustainable competitiveness; investments and funding; research & innovation (R&I) techniques and technological solutions; regulation and public governance; infrastructure; skills; and the social dimension. As part of this transition pathway, stakeholders agreed to include an additional building block on 'access to energy and feedstock', which will be instrumental for the chemical industry's transformation.

[18] As stated in the disclaimer and legal notice, results of the stakeholder co-creation process presented in this report do not necessarily represent the position of all stakeholder groups nor the position of individual Member States or the Commission.

affect chemical value chains, with ripple effects across the EU's entire economy. Furthermore, some imported products not meeting the same environmental and safety standards in the production process required for goods manufactured in the EU continue to enter in the internal market. Ensuring a level global playing field is key to creating a market advantage for safe and sustainable chemicals.

Stakeholders conclude that to strengthen the competitiveness of the chemical industry, it is necessary to improve international competitiveness; to reduce existing unsustainable dependencies and supply chain vulnerabilities while avoiding new ones; to continue enhancing the safety and sustainability of chemicals and materials; to pursue the innovation and growth of SMEs; and to foster new synergies.

Improving the international competitiveness of the EU chemical industry implies a better understanding of the recent geopolitical developments and the economic consequences for the industry. To this end, stakeholders suggest undertaking an analysis of the medium-to-long-term impacts of the energy crisis caused by Russia's war of aggression in Ukraine on both: (i) the sustainable competitiveness of the EU's chemical industry; and (ii) the industry's ability to develop and innovate. The outcome could better define existing and new initiatives by the global industry[19] to further promote EU environmental and safety standards globally. Finally, stakeholders recommend setting Key Performance Indicators (KPIs) and sustainable development indicators to measure and compare the international competitiveness of the EU's objectives for the chemical industry and the progress made towards climate neutrality; and to achieve safe and sustainable by design (SSbD), processes, and derived products, followed by regular progress reports. These should be embedded with existing key performance indicators and indicator sets.

There also seems to be a need for promotion of the market for sustainable products. This implies the development, commercialisation, deployment and promotion of the uptake of SSbD substances and materials. Stakeholders suggest achieving this through financial support – especially to SMEs – under Horizon Europe, cohesion policy, the LIFE programme, other relevant EU funding and private investment instruments, and public-private partnerships. It implies also the need to develop 'market pull' measures and incentives encouraging customers (including public procurers) to purchase sustainable products, despite their higher costs.

The table below summarises actions proposed by stakeholders on international competitiveness.

Topic 1: International competitiveness		
Actions	Actors	Timeframe
1.1 Drive international competitiveness		
• Analyse medium to long-term impacts of energy crisis on sustainable competitiveness and ability to develop	Industry and EU/MS	S
• Set key performance indicators and sustainable development indicators *(Linked to Topic 3.1)*	Industry and EU/MS	S
• Global industry initiatives (new and existing) to further promote EU environmental and safety standards globally	Industry and EU/MS	S/M

[19] For example, the Responsible Care Initiative by the ICCA, the International Council of Chemical Associations.

1.2 Promote the market for sustainable products

• Develop, commercialise, deploy and promote the uptake of SSbD substances and materials	Industry and EU/MS	S
• Ensure that hazardous chemicals banned in the European Union are not produced for export including by amending relevant legislation if and as needed	EU	S
• Develop 'market pull' measures and incentives to purchase sustainable products with higher costs	EU/MS	M

For several chemicals, including chemicals essential for strategic value chains, the EU relies heavily on a limited number of suppliers located outside the EU, because manufacturers can no longer profitably produce them or because the chemical industry's customers are no longer producing in Europe. This impacts the EU's open strategic autonomy, as seen during the pandemic. To avoid further shrinkage of the market and to limit the dependence of EU value chains on manufacturers outside the EU, the chemical industry is investing in innovation in raw-material value chains. This is an area that remains untapped despite its great potential. Further information on supply chains seems therefore necessary. To this end, stakeholders suggest undertaking a strategic foresight exercise for the chemical industry with a specific focus on the EU's open strategic autonomy[20]. This exercise should also link with the EU's current activities on securing access to critical raw materials. An assessment of the need to build up and maintain strategic stocks of critical raw materials within the EU is also recommended.

The chemical industry is one of the most globalised industrial sectors in the EU and is therefore highly dependent on open and fair trade. The COVID-19 crisis and Russia's war of aggression against Ukraine have shown that the EU is still import-dependent for supplies of energy, metals, several speciality chemicals, and many raw materials, all of which are essential for strategic value chains[21]. The EU supports efficient, transparent and cost-effective approaches to chemicals management with its trading-partner countries, within a level global playing field. Stakeholders state that closer international cooperation and coordination can be promoted by the EU at a global level (e.g. via multilateral and bilateral fora) and in particular by expanding initiatives on developing and implementing global standards to ensure that the current regulatory gap and divergence do not widen between the EU and the rest of the world.

Free-trade agreements (FTAs) remain a cornerstone of EU trade policy, focusing on: (i) the elimination of tariffs and non-tariff barriers; (ii) the facilitation of cross-border trade; (iii) striving for the simplest customs procedures; (iv) rules of origin; (v) digitalisation of all required documentation; and (vi) making logistics systems as flexible as possible. Stakeholders suggest that FTAs should be ratified and ideally include a dedicated section on cooperation in the regulation of chemicals, for example in an annex.

Further integration of the EU's single market for energy, and an open single market for plastic waste and secondary raw materials will also strengthen the resilience and autonomy of the

[20] COM(2021) 750 final. 2021 Strategic Foresight Report. The EU's capacity and freedom to act https://europa.eu/!743jQV and ongoing study on foresight for chemicals by EU4Chem project.

[21] SWD(2022) 41 final. Commission Staff Working Document on EU strategic dependencies and capacities: second stage of in-depth reviews https://ec.europa.eu/docsroom/documents/48878.

EU and its chemical industry. It will also reduce the EU's dependence on chemicals from countries outside the EU.

To reduce unsustainable dependencies on countries outside the EU and the chemical industry's own vulnerability to external shocks, stakeholders suggest actions in the table below.

Topic 2: Reduction of unsustainable dependencies and supply-chain vulnerabilities		
Actions	Actors	Timeframe
2.1 Gather supply-chain information		
• Undertake a strategic foresight exercise focusing on the EU open strategic autonomy (link with critical raw materials)	Industry and EU/MS	S
• Assess the need to build up and maintain strategic stocks of critical raw materials within the EU	Industry and MS	S/M
2.2 Increased collaboration within sub-sectors		
• Secure long-term supply contracts for critical raw minerals/metals, while assessing and accounting for any environmental and socioeconomic implications of the critical raw materials and their long-term sourcing plans	Industry and EU/MS	M
2.3 Make the most of existing international partnerships, including FTAs		
• Start or strengthen international (regulatory) economic cooperation (e.g. making use of OECD and WTO mechanisms), especially with the EU's most important trading partners. Prevent potential barriers to market access (e.g. related to the use of waste as feedstock) *(Linked to Topic 1.1 and Topic 13)*	Industry and EU/MS	M
2.4 Increase resource efficiency		
• Apply 'energy-efficiency first' as a key principle and prevent losses of materials by increasing circularity according to the '3R' principle (reduce, re-use, recycle), without hampering the implementation of new low-carbon processes (e.g. electrification, CCU (carbon capture and utilisation), CCS (carbon capture and storage), etc.)	Industry	S/M
• Support the circular economy. Take into consideration whole value chains when designing 'circular' industrial processes and ensure that all raw materials are included in these processes (including plastic waste, bio-based/biomass products and CO/CO_2 emissions) to close loops, ensure resource efficiency and reduce dependencies, with public policy supporting 'end-of-waste' concept	Industry & EU/MS	S/M

To ensure the 'circularity' of chemicals, it is crucial to apply safe and sustainable by design principles and to have design principles that are safe and sustainable and to consider the specificities in each lifecycle step when developing chemicals and materials. For this purpose, the Commission is developing a detailed and workable framework and criteria to develop new chemicals and materials, optimise or redesign production processes and the use of substances currently on the market to improve their safety and sustainability for ensuring that industrial

processes are SSbD[22]. This will promote economic growth and foster innovation in substances, mixtures and materials. This in turn will advance the transition towards a circular economy, and a zero-pollution and climate-neutral society by 2050.

Finally, digital product passports can be an important enabler for the deployment of sustainable and 'circular' products. This is because digital product passports would make it possible to communicate information on chemicals and their sustainability characteristics within the value chain, while complying with competition rules and rules on the confidentiality of data. Stakeholders suggest that digital tools could provide added value for the circular economy while guaranteeing efficient implementation, considering solutions that are already available on the market.

To support the market uptake of SSbD chemicals, stakeholders recommended taking the actions in the table below.

Topic 3: Safety and Sustainability		
Actions	Actors	Timeframe
3.1 Develop a detailed and workable framework and criteria for ensuring that industrial processes are SSbD		
• Maintain an EU-wide SSbD support network to promote cooperation and the sharing of information across sectors and the value chain, and provide technical expertise on alternatives	EU/MS	S /M
• Industry and MSs should engage in the testing phase of the SSbD framework	Industry and EU/MS	S/M
3.2 Improve collaboration in value chains		
• Engage in Hubs4Circularity as well as a Circular Cities and Regions Initiative (Horizon Europe)	Industry and EU/MS	S
• Explore the potential role of digital innovation hubs in the chemical industry	EU and Industry	S
• Use data spaces to improve resource allocation, supply chain resilience and the manageability of circular processes.	EU, Industry and MS	S/M
• Promote interregional collaboration along sustainable value chains in the chemical industry through smart specialisation to accelerate the development of joint investment projects	EU	M
• Set up and invest in 'reverse logistics' to ensure that materials are not turned to waste	Industry and MS	M
3.3 Support substitution to safer chemicals as well as product design and re-design		
• Implement and enforce the Ecodesign for Sustainable Products Regulation (ESPR), as part of the new circular economy action plan (CEAP)[23]	EU/MS	S/M

[22] Commission Recommendation (EU) 2022/2510 of 8 December 2022 establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022H2510.

[23] COM(2020) 98 final. A new Circular Economy Action Plan for a cleaner and more competitive Europe https://europa.eu/!Tg93Ug.

• Proposals to extend the generic approach to risk management to ensure that consumer products do not contain chemicals that cause cancers, gene mutations, affect the reproductive or the endocrine system, or are persistent and bioaccumulative and toxic; assess the modalities and timing to extend the same approach to further chemicals including those affecting the immune, neurological or respiratory systems and chemicals toxic to a specific organ; proposal to restrict PFAS under REACH for all non-essential uses including in consumer products	EU	S
• Support the uptake of new business models (e.g. facilitate the chemical 'leasing' concept within public tendering; engage and/or support projects on digital product passports that aim at passing along information on chemicals and other sustainability assets within the value chain)	Industry	S/M
• Develop digital infrastructure for data spaces to share high-quality data on products' environmental footprint, including the GHG footprint of products and applications (up to 'scope 3' emissions) and chemical-hazard profiles	Industry and EU/MS	S/M

Although the EU chemical industry includes many well-known large companies, most chemical companies are SMEs. Although both large companies and SMEs face common challenges, SMEs face particular difficulties when confronting both the twin transition and the war in Ukraine. SMEs often depend on single chemical products and limited portfolios in their offering of products for sale. They are also often deeply rooted in the region where they operate and cannot easily move production or swiftly re-design products, or introduce completely different business models. Accessing EU funding for research and innovation is also more complex for SMEs, as they often lack the time, experience and skilled staff necessary to successfully apply for this funding. As they typically have few employees, SMEs rarely have dedicated staff to manage regulatory changes. Furthermore, SMEs face particular challenges to digitalisation, including a lack of knowledge about which technologies to adopt and who should provide them, where to get digitalisation advice and support and how to access finance for digitalisation. They also often lack the (digital and managerial) skills needed to digitalise the business and make the necessary organisational changes to accommodate them. To address these challenges and support the digitalisation of SMEs, the European Commission and the Member States are jointly investing EUR 1.5 billion (e.g. Digital Europe Programme/RRF/ERDF) over the next 7 years in a network of European Digital Innovation Hubs (EDIH). The EDIH are one-stop-shops providing SMEs (and public sector organisations) with tailor-made advice and support (training, "test-before-invest", access to financing, match-making services etc.) to aid their successful digital transformation. "Test-before-Invest" opportunities are particularly important to support digitalisation in the Chemical industry as it allows companies to see first-hand if and how technologies can benefit their business. Therefore, reducing uncertainties and risks associated in investing in expensive new technologies. The network, which is just starting its work, will cover all EU regions and address the digitalisation needs of SMEs in all sectors, including chemicals.

Data spaces are not only used in mechanical engineering, but also in the process industry. The benefits of data spaces are similar in the different industrial sectors; they are about increased transparency and efficiency of processes. The European Data Spaces provide the necessary infrastructure and governance models, which also allow for effective and fair

involvement of SMEs. Through cross-company data exchange, the participants of Catena-X, for example, expect to improve the predictability, plannability and resilience of supply chains as well as the manageability of circular processes and the cost-efficient fulfilment of regulatory requirements. The table below summarises actions that could unleash the innovation and growth potential of SMEs according to stakeholders.

Topic 4: Innovation and growth of SMEs		
Actions	Actors	Timeframe
4.1 Strengthen cooperation with the start-up ecosystem		
• Develop tools and policies to promote cooperative buying in compliance with competition rules	Industry and EU/MS	S
• Support SMEs in their supply chains also by connecting to EIT Knowledge and Innovation communities	Industry	S
• Improve communication by fostering information exchange to promotion success stories	Industry and EU/MS	S
• Strengthen the Enterprise Europe Network	EU/MS	S
• Develop modular production processes to enable local and regional chemical economies	Industry	M
4.2 Support the successful implementation of the network of European Digital Innovation Hubs (EDIH)		
• Provide information to and encourage SMEs to make use of the digitalisation support services provided by the EDIH network.	Industry/MS	S/M
• Ensure the EDIH are appropriately funded	EU/MS	S/M
4.3 Strengthen initiatives with SMEs under the European Innovation Council (EIC)		
• Encourage SMEs to make use of open innovation test beds[24], which can bring both co-development and the testing of new substances and advanced materials within the reach of companies and users	Industry/MS	M
• Further support access for SMEs to national funding opportunities, which can complement funding received from the EIC programme	EU/MS	M
4.4 Support compliance with legislation and funding for new technologies		
• Communicate on funding opportunities *(Linked to Topic 7.1)*	Industry (trade federations)	S
• Assess the need for – and develop, if needed – regulatory sandboxes for regulatory testing and learning	Industry/MS	S
• Promote access to risk finance, in particular for SMEs and start-ups, and consider facilitating industrial research, e.g. through increased building of skills at local and regional level	EU/MS	S/M

[24] Sustainable production processes. See https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/sustainable-production-processes_en

(Linked to Topic 7.1)		
• Develop and promote 'plug-and-play' technologies with an appropriate regulatory framework and standards, and support from Member States	Industry/EU/MS	M

Maintaining existing synergies and developing new synergies will contribute to the sustainable competitiveness of the chemical industry. These synergies can be promoted by activities such as: (i) encouraging a high level of integration in chemical plants and within the sector more broadly; and (ii) further integrating projects in the chemical industry with projects in other sectors that contribute directly to resilience and the twin transition. In particular, greater integration between the chemical industry and the waste sector, (or other energy-intensive industries such as the steel, cement and energy sectors,) will be key to further increasing circularity, resource efficiency and energy efficiency.

Additionally, stakeholders suggest there is a need to improve the processes for designing chemicals and a need to adopt a full 'lifecycle' approach from the start, by increasing cooperation among the different value chains with manufacturers of end-products. The table below summarises actions suggested by stakeholders for the creation of new synergies.

Topic 5: New synergies		
Actions	Actors	Timeframe
5.1 Facilitate the exchange of information		
• Maintain the Euroclusters initiative, which aims to create partnerships of cluster organisations	EU/MS	S
• Facilitate cooperation in value chains and sectors through the ongoing revision of antitrust rules	EU/MS	S
5.2 Increase collaboration to de-risk investments		
• Increase the number of joint projects to de-risk investments (e.g. joint projects on CCS and the electrification of crackers)	Industry	S
• Increase cross-border projects on the generation and supply of energy and feedstock, such as grids, pipelines, renewable carbon, and CO_2 transport	EU/MS	M
• Consider incentivising processes that would increase the value of industrial waste and the CO_2 emissions it generates	EU/MS	M
5.3 Support the development of partnerships for innovation		
• Ensure shared access to the research and technology infrastructures as part of the European Research Area	EU/MS	S
• Undertake joint cross-sectoral projects that could qualify as important projects of common European interest (IPCEIs)[25]	Industry	S
• Strengthen and develop synergies with all players in the chemicals value chain[26]	Industry	M

[25] E.g. chemicals and waste, chemicals and steel, etc. to reduce emissions in the chemical industry in line with EU objectives. IPCEIs are a State aid instrument and have to comply with State aid rules, in particular the Communication from the Commission on criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest (C/2021/8481 final) https://europa.eu/!NWcVp3.

[26] Producers of chemicals and materials, manufacturers of end-products, and the waste sector (e.g. in construction, textiles, transport, electronics, digital, renewables, aerospace, and defence).

• Support new data-driven business models based on Common European Data Spaces	Industry & EU/MS	M

2) INVESTMENTS AND FUNDING

The transition to a climate-neutral, safer, zero-pollution, and 'circular' chemical industry, including the development of safe and sustainable alternatives for substances of concern, will require major R&I investments (see textbox below). The development of new products and the implementation of the supply chain for their manufacture can easily take 5 years or more, especially for complex formulations.

Industry reports that one of the key hurdles for investing in the chemical industry's transformation is the risk linked to 'first-of-a-kind' solutions, and the risk of not being able to scale up. These two risks are driven by a changing regulatory context and the uncertain financial return from making these investments. The chemical industry requires high CAPEX for initial investments, combined with significantly higher OPEX to modify its production processes and to purchase energy and feedstock from alternative sources. Increasing the industry's confidence that these investments will produce a positive return would boost funding for innovative products and/or processes, and also foster the market for new products. In this respect, additional attention must be paid to the international competitiveness of EU companies.

Estimations by Process4Planet

The Processes4Planet Partnership (P4P) under Horizon Europe estimates that EU-wide investments needed to develop the first of a kind commercial low-carbon and circular technologies in the chemical industry are in the region of EUR 218-238 billion[27]. It also estimates that additional investments in the order of trillions[28] are needed to fully deploy these technologies across Europe including also electric-power production, supply chains and transport. The P4P partnership also estimates that ensuring the operation of industrial plants based on low-carbon technologies will require an average additional investment of EUR 3.9-5.5 billion per year[29]. The gradual transition from one system to another will require some degree of parallel production systems, with dual investments required in both systems for a period as a result (transition costs). From the mid-2030s, a need for increased investments will be expected driven by higher intrinsic CAPEX associated with some low-carbon processes and with CCS (Carbon Capture and Sequestration).

The chemical industry possesses significant physical assets, but investments are needed to secure the long-term sustainability of these assets. Major equipment or plant retrofitting demand long-term planning (including an R&I plan) and large capital investments.

The dismantling, retrofitting or rebuilding of existing assets may be opposed by shareholders if existing assets are not fully depreciated and still generate revenues (stranded assets). 'Drop-in' solutions may allow the prolonged use of existing assets and thereby enable fast retrofitting and minimise stranded assets. An action plan should be developed with the authorities to manage these existing assets and convert them or replace them with more sustainable

[27] See Processes4Planet SRIA, October 2021, p. 96 "*A more accurate estimation of investment needs for deployment would require more detailed analysis, and the overall figure will depend on the investments included"* […].

[28] See Processes4Planet SRIA, October 2021, p. 97 and 18.

[29] See: European Commission, 2021. ERA industrial technology roadmap for low-carbon technologies in EIIs, p. 5, Figure 26. Investments needs across the 3 pathways to net-zero.

alternatives. Investment timelines must take into consideration the industry's long investment cycles and the need for pilot and demonstration plants. New business models will have to be scaled up and proven to win the confidence of investors.

Summary of discussion on chain-of-custody principles emerged during the co-development meetings

Industry also points out the lack of officially acknowledged chain-of-custody principles. Industry stakeholders say that these principles would be an effective instrument in helping to finance the extra cost of sustainable feedstocks and energy. There is already strong existing consumer demand for more sustainable products, and products produced according to chain-of-custody principles could help to attract consumers to pay a premium. Chain-of-custody models, such as the mass-balance-credit method, may enable new sustainable and circular industrial models to emerge, making it possible to process different raw materials (fossil feedstock, CO2 from industrial emissions, biomass and recycled waste) in the same installation or plant. These are typically installations that already exist, and chain-of-custody principles makes it possible to allocate different raw materials to specific products that can bear the extra cost. This gradual feedstock shift would allow the timely conversion of chemical production plants to environmentally sustainable production processes. The mass-balance-credit method could become the key enabler for a significant demand-driven and consumer-financed step in the transition to a sustainable chemicals industry. Some stakeholders and civil-society representatives note that, for the mass-balance approach to be honest, transparent, traced and credible when applied to the chemicals industry: (i) there must be a physical connection between the waste and the desired end-product; and (ii) the claimed percentage of recycled content must correlate to the actual content. Consumers could be misled if there are no standards on traceability and transparency[30]. The application of the mass-balance-credit approach to chemicals remains controversial and under discussion at EU level, notably as part of Renewable Energy Directive (RED) revision.

National energy and climate plans, which Member States are currently updating[31], have a crucial role to play in increasing both investor confidence and the predictability of investments. They provide a good framework for planning and encouraging reductions in the use of fossil fuels and resources, thus providing more certainty and predictability overall. The table below summarises actions supporting funding for green investments proposed by stakeholders.

Topic 6: Fund for Green Investments		
Actions	Actors	Timeframe
6.1 EU Taxonomy to support the CSS		
• Consider drawing up delegated acts and FAQs to support the Taxonomy Regulation implementation ensuring the consistent interpretation of the relevant economic activities	EU	S

[30] E.g. see ZeroWasteEurope, 2021. Determining recycled content with the 'mass balance approach'.

[31] In accordance with the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action; Member States have to update their national plans for 2021-2030 in a draft version by June 2023 and in their final version by June 2024.

• Continue fostering global dialogue and coordination on sustainability taxonomies through the International Platform on Sustainable Finance	EU	M
6.2 Develop hub structures		
• Develop hub structures to increase investment in the development and uptake of cross-sectoral low-carbon industrial technologies[32]	Industry and EU/MS	M
• Consider drawing up meaningful, harmonised and applicable sustainability-assessment methodologies and tools to stimulate collaborative innovation, with hubs as the entity charged with promoting these methodologies and tools (e.g. Hubs4Circularity [Horizon Europe], Circular Cities and Regions Initiative) *(Linked to topic 3.2 and 5.2)*	EU/MS	M
6.3 Manage and convert existing assets		
• Adopt a transition plan on the conversion or replacement of existing assets, while taking investment cycles into account *(Linked to Topic 11.2)*	Industry	S
• Facilitate and accelerate permitting procedures for plant investments and participate in communities of practice on permits[33] *(Linked to Topic 10.2)*	EU/MS	S
• Support (incl. financial) for retrofits and transformation that aim at effective and innovative low-carbon technologies and sustainable solutions	EU/MS	M

Public funding can be an efficient way to limit the risk of investment and can also be a useful complement when market incentives and regulation are not sufficient to drive investments. For instance, the EIC supports breakthrough and transformative innovation under the Horizon Europe programme. Through its tailored approach for start-ups and SMEs[34]; the EIC addresses innovators regardless of the maturity of the technology that they are developing. The overall funding of the EIC for 2021-2027 is EUR 10.1 billion. Industry associations stress that access to those funding mechanisms should generally be made easier and that all subsidies linked to the European Green Deal should be increased. Additionally, the ETS Innovation Fund[35] supports the commercial demonstration and de-risking of innovative low-carbon technologies, including projects in the chemicals sector. The fund will provide around EUR 38 billion of support from 2020 to 2030 (at a carbon price of EUR 75 per tCO_2). Resources for industrial transformation are also available through other funds, as the Just Transition Fund, the Recovery and Resilience Fund and the Modernisation Fund. Finally, the European Social Fund is well suited to focus on reskilling of the workforce for such a transition.

SMEs play a significant role in creating further synergies at industry level to develop and promote the widespread use of new industrial technologies. They should continue to do so in the future while driving the transition of energy-intensive industries to climate neutrality.

[32] See: European Commission, 2022. ERA industrial technology roadmap for low-carbon technologies in EIIs, p. 144.

[33] See: European Commission, 2022. ERA industrial technology roadmap for low-carbon technologies in EIIs.

[34] At least 70% of EIC budget shall be dedicated to SMEs, including start-ups.

[35] See https://climate.ec.europa.eu/eu-action/funding-climate-action/innovation-fund_en