European Environment Agency

Managing the systemic use of chemicals in Europe

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Chemicals are embedded in practically every single manufactured good in the EU. On the one hand, chemicals play a key role in ensuring quality of life and offer new solutions to deliver the green and the digital transitions. On the other, our increasing reliance on chemicals leads to serious problems. From creating adverse health effects to contributing to the climate crisis, chemicals come with a cost — so much so that we have now exceeded the planetary boundary for chemical pollution. Where do we go from here? This briefing describes the systemic use of chemicals across Europe's current systems of production and consumption. Moreover, it discusses key policy measures foreseen in the European Green Deal's Chemicals Strategy for Sustainability that offer significant potential to ensure consumer safety, cut pollution and clean up material flows.

Key messages

- The growing volume and diversity of chemicals in use hinder authorities from adequately assessing and managing the associated risks to human health and the environment. Tackling groups of chemicals rather than single substances could accelerate chemical risk assessment and management.
- EU production and consumption of chemicals and downstream products impact the environment and health, both within and outside Europe. Evidence shows that the planetary boundary for chemical pollution has been exceeded.
- Chemical production is tightly integrated into the fossil fuel sector, with petrochemicals used as both feedstock and an energy source for production. There is increasing awareness that our reliance on chemicals and downstream products, such as plastics and fertilisers, is reinforcing our dependence on fossil fuels.
- The presence of certain chemicals in specific material flows can prevent re-use or recycling, presenting a barrier to the circular economy.
- Transitioning to chemicals that are safe and sustainable by design and applying the essential use concept to upstream chemical risk management can enable the chemical industry to provide technologies, materials and products that are non-toxic, low-carbon and fit for circularity.

In this briefing, the term ‘chemicals’ covers both synthetic chemicals and those that are unintentionally released by human activities, including naturally occurring chemicals such as heavy metals.

Europe’s systemic use of chemicals

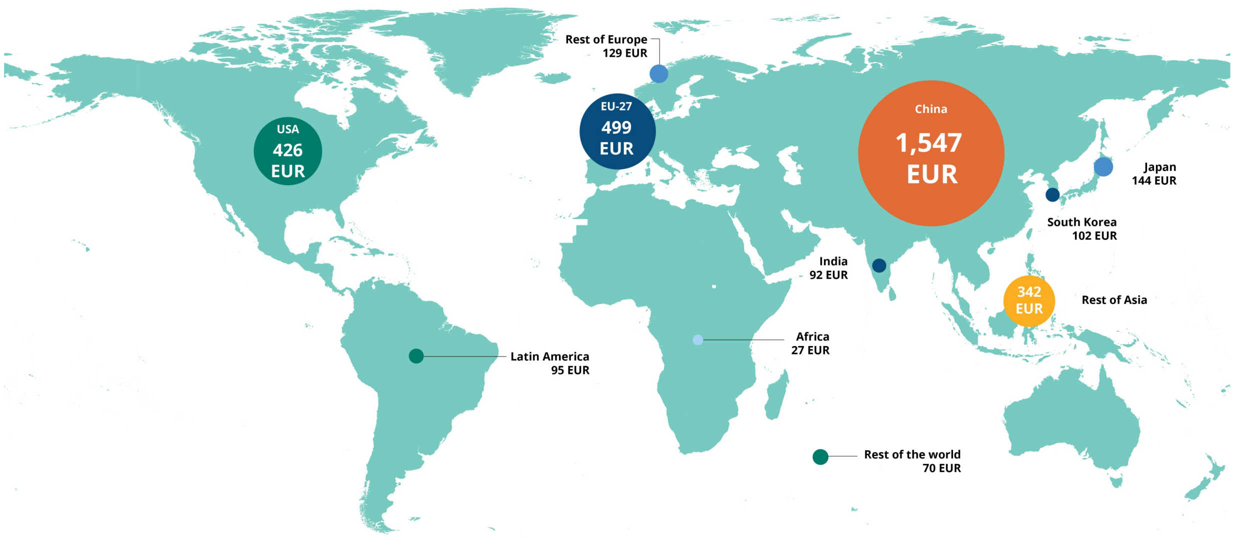
The chemical industry is intrinsically bound to Europe’s production and consumption systems as an upstream supplier to all economic sectors; in particular, manufacturing, agriculture, energy and healthcare. Virtually all manufactured goods contain chemicals, with chemicals being key components of plastics, textiles, cosmetics, cleaning products, paints, glues and a broad range of other consumer products. Therefore, the chemical sector plays a key role in improving quality of life in Europe.

At the same time, chemical pollution in the environment continues to degrade biodiversity and jeopardises clean water, pollination and healthy soils (EEA, 2022a). The pervasive use and release of chemicals means that today, the bodies of European citizens are contaminated with a large number of chemicals of concern — some at levels damaging to health (Socianu et al., 2022). In terms of public awareness, 84% of Europeans are concerned about chemicals in everyday products impacting their health, and 90% are worried about their impact on the environment (Eurobarometer, 2020).

The volume and diversity of chemical production

The production capacity of the global chemical industry almost doubled between 2000 and 2017 — reaching about 2.3 billion tonnes, with particularly rapid growth seen in China and India (UNEP, 2019). The total value of chemical sales reached €3.5 trillion in 2020, with the EU being the second largest chemical producer by sales value in the world after China (CEFIC, 2022a) (see Figure 1).

Figure 1. World chemical sales by country, 2020



Source: CEFIC, 2022a

In terms of volume, EU production hit 271 million tonnes in 2020, while consumption (net import plus production) stood at 289 million tonnes (Eurostat, 2022a). In contrast to the global trend, EU chemical production volume fell by 10% from 2004 to 2020 (Eurostat, 2022a). High energy costs in Europe reduce the competitiveness of the European chemical industry in relation to that of players in regions with more favourable energy prices (CEFIC, 2022a). Nevertheless, the value of total EU chemical sales increased by 38% from €363 billion in 2000 to €499 billion in 2020.

Going forward, global chemical production is expected to double from 2017 to 2030 because of the demand for chemicals across downstream industries. World chemical sales are expected to reach €6.2 trillion in 2030, at which point the EU-27 chemical industry is expected to rank third globally in terms of sales volumes (CEFIC, 2022a).

The EU's Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) explicitly aims to ensure that the most hazardous substances are substituted with less dangerous ones via authorisation and restriction. A recent report from the European Chemicals Agency (ECHA) found that volumes of 59 substances of very high concern that were subject to authorisation under REACH and placed on the EU market fell by 45% in the EU between 2010 and 2021. For some substances, the decline was even steeper: the production and import of five phthalates and trichloroethylene decreased by more than 90% in roughly a decade (ECHA, 2022a). From 2004 to 2020, EU production of chemicals known to be hazardous to health fell by 12%; at the same time, production of chemicals that are carcinogenic, mutagenic and reprotoxic fell by 16% (Eurostat, 2022a).

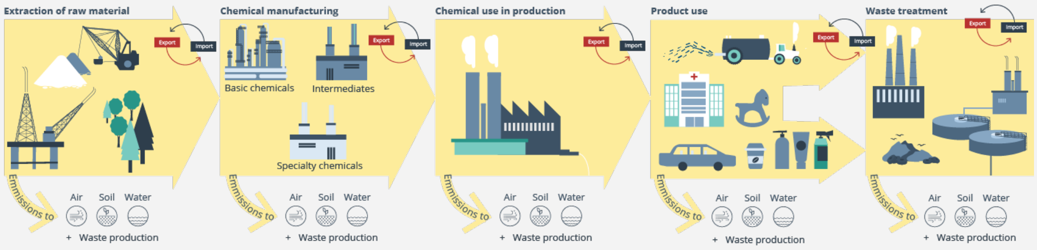
In terms of the diversity of chemicals on the EU market, over 26,600 chemicals were registered under the EU REACH legislation in December 2020 (ECHA, 2022b). However, this number omits chemicals on the market at volumes below 1 tonne, as well as polymers, active substances in pesticides, biocides and pharmaceuticals. At the global level, there are an estimated 350,000 chemicals on the market (Wang et al., 2020). Chemicals used in manufacturing outside Europe are imported in finished products and emissions along the product's life cycle occur in Europe. Available information on substances imported in products is more limited. Under REACH, companies importing products to Europe must be informed by the exporting companies if those products contain substances of very high concern above a certain level and are required to pass this information on to retailers and to consumers upon request. The European Rapid Alert System for Dangerous Products (RAPEX) is the EU's system for exchanging information on unsafe consumer products for consumer protection, established under the General Product Safety Directive. In 2021, 73% of safety alerts related to products originating from outside the European Economic Area, while 25% of safety alerts signalled a chemical risk (EC, 2022).

Chemicals also flow out of Europe. Stakeholders have raised concerns that the EU exports hazardous chemicals that are banned in the EU because of environment and health concerns to third countries where regulations are generally weaker (Corporate Europe Observatory, 2022), including pesticides and industrial chemicals (ECHA, 2021). This highlights the importance of the commitment in the Chemicals Strategy for Sustainability for the EU to ‘lead by example’ by ensuring that hazardous chemicals banned in the EU are not produced for export.

The chemical life cycle

The value chain of the chemical industry (Figure 2) and the life cycle of any single chemical are typically complex. They span global to local levels, with chemical products traded across multiple countries along the chain and incorporated into complex manufactured products.

Figure 2. The chemical value chain

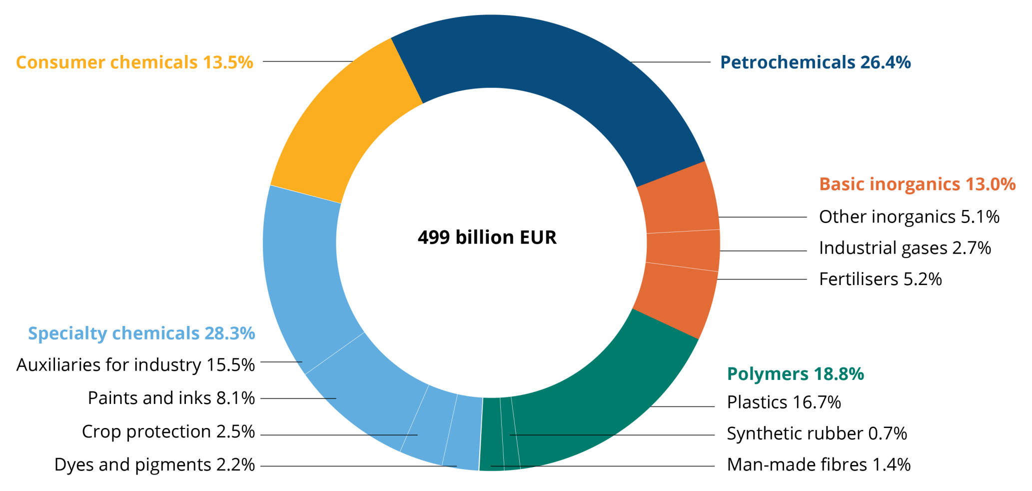


First, feedstocks — such as oil, natural gas and minerals — are processed into high-volume and low-value basic chemicals, including polymers, petrochemicals and basic inorganics. In the EU, basic chemicals account for 58% of production by value, with petrochemicals making up 26% of this (see Figure 3). Higher value specialty chemicals include agricultural chemicals such as pesticides, fertilisers and biocides, as well as cosmetics, fragrances and flavourings. They also include plasticisers and inputs to consumer products, such as electronics, cars, textiles, cosmetics and toys. Some chemical mixtures are directly used by consumers, such as cleaning products, paints and glues. The production chains of the chemical industry are complex and interlinked, as the different types of chemicals are combined to form new ones.

This vast range of products is then used by consumers, business to business and professionals. The duration and nature of the ‘use’ phase vary greatly. While products such as washing powders and pharmaceuticals are consumed in one use, furniture, cars and building materials remain in use for decades. Certain chemical products, such as cleaning products, cosmetics and pharmaceuticals, are released down the drain and enter urban wastewater treatment plants. Even advanced treatment plants cannot remove certain chemicals, which often concentrate in sewage sludges or are released into surface waters. Other chemicals — including pesticides, biocides and fertilisers, as well as chemicals used in fracking and to disperse oil spills — are directly released into the environment upon use. ‘Unintentional’ release also occurs through the wear and tear of chemical-based products, such as tires, paints and synthetic microfibres and textiles.

Following use, waste is sorted into recyclable material or items for reuse, or is channelled to end-of-life handling. For a very limited volume of chemicals, recycling closes the life cycle loop by returning some chemicals back to circulation, for example, through the recycling of plastic polymers. Chemical waste and materials may also find their way to the environment via consumer or professional spills and illegal waste dumping.

Figure 3: Sales value of chemical production in the EU-27 in 2020, sorted by category



Source: CEFIC, 2022a

Dependencies and carbon lock-ins: petrochemicals, fertilisers and plastics

The chemical and petrochemical industry is energy-intensive, accounting for 22% of the total final energy consumption in industry in the EU in 2020. This makes it the largest energy consumer in industry overall (Eurostat, 2022b). In terms of greenhouse gas emissions, in 2019, the direct emissions of the chemical sector contributed 3.2% of total EU greenhouse gas emissions (EEA, 2021a). The EU chemical sector has reduced its direct greenhouse gas emissions markedly since 1990, with a total reduction of 55% between 1990 and 2019 — largely due to a significant fall in emissions of nitrous oxide (N_2O) (EEA, 2022b).

Chemical production processes generate by-products that feed other processes, leading to co-dependencies and lock-ins to existing technological systems. Petrochemicals are derived from fossil fuels, mostly petroleum and natural gas, with small volumes derived from coal. At the global level, just seven petrochemicals (methanol, ethylene, propylene, butadiene, benzene, toluene and xylene) feed more than 90% of downstream organic chemical production (American Chemistry Council, 2020). The two largest downstream product categories for the petrochemicals industry are nitrogenous fertilisers and plastics.

In the EU, fertiliser use continues to grow, with 10 million tonnes of nitrogenous fertiliser used by agriculture in 2020, an increase of 8.3% from 2010 (Eurostat, 2022c). These fertilisers are produced from natural gas, with the EU's nitrogen-based fertiliser industry heavily dependent on gas of Russian origin. The military aggression in Ukraine and sanctions on Russia have led to a sharp rise in fertiliser prices, which will likely impact fertiliser use in agriculture in the EU (EC, 2022a). In terms of environmental impacts, excess fertiliser application is linked to nutrient losses from agriculture to the environment, driving eutrophication of freshwater and marine ecosystems (EEA, 2022a).

Plastic production is another example in which the upstream production of basic petrochemicals is profoundly dependent on and integrated with the fossil fuel sector, both as feedstock and as the primary source of energy (EEA, 2021b; Tickner et al, 2021). Plastics are composed of polymers produced by the petrochemical industry, including polyethylene, polypropylene, polyethylene terephthalate, polyvinyl chloride and polystyrene, and are the sector's largest product category (Bauer et al, 2022). The total greenhouse gas emissions caused by the EU plastics value chain in 2018 are estimated at 208 million tonnes of carbon dioxide equivalent (CO_2e). The majority (63%) of greenhouse gas emissions results from polymer production, while converting polymers into products accounts for 22%. The treatment of plastic waste at end-of-life accounts for another 15%, mainly because of incineration (ETC/WMGE, 2021).

Rising EU demand for plastics has contributed to the increasing carbon footprint of plastics at the global level. Outsourcing plastic production to regions outside Europe that use coal as an energy source, such as China, has increased the EU's plastics-related carbon footprint (EEA, 2021b). This is despite the fact that domestic plastics-related greenhouse gas emissions fell (Cabernard et al., 2022).

Society's dependency on plastic to deliver a vast range of functionalities and products therefore reinforces our reliance on fossil fuels (EEA, 2021; Bauer and Fontenit, 2021). Aside from climate concerns, plastic pollution in aquatic and terrestrial ecosystems is of concern, with evidence of human exposure to plastics via drinking water and diet (EEA, 2021b; EEA, 2022a). The annual intake of microplastics by humans has been estimated to range from 70,000 to over 120,000 particles (Cox et al., 2019), with microplastics detected in human blood and stool (Schwabl et al., 2019; Leslie et al., 2022). Another concern is how microplastics in sewage sludge impact soils. Microplastics are filtered out from wastewater and end up in sludge, which is then spread onto agricultural land as fertiliser in many European countries. One study estimates that microplastic contamination in soil amounts to 31,000-42,000 tonnes (Lofty et al., 2022) across Europe.

The zero pollution action plan set the target to reduce plastic litter at sea by 50% and microplastics released into the environment by 30% by 2030, compared to 2016. Plastics constitute the bulk of marine litter and are present in all marine ecosystems, with waste accumulating on shorelines, the seabed and surface waters. Marine litter harms marine biota through entanglement or ingestion, contaminant transfer and by acting as a transport vector for pollutants. Plastic and contaminant accumulation in marine biota and, potentially, the transfer of pathogens also threaten human health (Revel et al., 2018). Further information on plastic pollution is available in the EEA report From source to sea – The untold story of marine litter (EEA, 2023), the zero pollution cross-cutting story on plastics and in the EEA report on plastics, the circular economy and Europe´s environment (EEA, 2021b).

European countries lack the capacity to manage growing amounts of plastic waste in circular and sustainable ways. In 2018, 29 million tonnes of plastic waste were collected in Europe (EU-28, Norway and Switzerland), of which it has been estimated that 32% was sent for recycling, 43% was incinerated and 25% was landfilled. In 2019, the EU exported over 1.7 million tonnes of plastic waste; this is half the volume exported in 2015 and 2016, when exports went primarily to China and Hong Kong. Chinese import restrictions drove the fall in exports of plastic waste, with remaining volumes re-routed to other countries in South East Asia, such as Vietnam, Thailand and Malaysia (EEA, 2021b).

Little is known about how plastic waste is managed in non-EU countries. Restrictions on imports of plastic waste in China, combined with some types of plastic being added to the Basel Convention, are likely to further decrease EU exports. This could lead to increased incineration and landfilling of plastic waste in Europe. In the longer term, it is an opportunity to improve capacities for reusing and recycling plastic waste within the EU, as well as preventing plastic waste in the first place.

The EU must find circular and climate-friendly ways to manage its plastic waste by increasing reuse and recycling (EEA, 2021c). Plastic recycling has the potential to reduce the impact of plastic waste and to close the loop in polymer production, including both mechanical and chemical recycling. Mechanical recycling is the principal technique for recycling waste polymers. Drawbacks include the need to effectively sort plastic waste input, the high price of recycled plastics compared to virgin plastics, water consumption for washing and the low quality of the resulting polymers when the waste plastic is mixed and contaminated with hazardous chemicals (EEA, 2022c; Ragaert et al., 2017). Over 6,000 chemicals have been identified in plastics, with over 1,500 of these categorised as of concern (Aurisano et al., 2021), presenting a barrier to plastic recycling. These challenges lead to quality loss in the recycling process (downcycling) and low market demand for recycled plastics. Closed-loop recycling, as well as improvements to sorting technology and traceability, offer solutions that can help maintain quality (EEA, 2021b).

Chemical recycling is a niche, albeit growing, technology. It covers a range of technologies from purification processes to separating plastics from other materials, as well as breaking down polymer chains using either chemicals (e.g. chemolysis) or heat (e.g. pyrolysis) (Ragaert et al., 2017). While chemical recycling can potentially increase the quality of certain types of recycled plastic, it is often highly energy intensive, leading to greenhouse gases. There are also concerns regarding the solvents, chemical reagents and catalysts used and the potential for pollution (Hann and Connock, 2020).

Chemical pollution as a barrier to circularity

Hazardous chemicals in material flows typically present a barrier to the circular economy, preventing products from being reused and/or recycled. Recycling products that contain hazardous chemicals is likely to contaminate flows of recycled materials, as it is more difficult to control the quality of recycled feedstock than virgin materials because of the cost of detecting and removing chemicals (WHO, 2018). In particular, recycling long-lasting products can contaminate material flows with hazardous chemicals that are today banned in Europe, known as ‘legacy chemicals’ (HBM4EU, 2022).

Examples include the transfer of bisphenols from thermal paper into a wider range of recycled paper products, including food packaging (Pérez-Palacios et al., 2012), and the transfer of lead and brominated flame retardants from waste electrical and electronic equipment into consumer goods such as kitchen utensils and toys (Fatunsin et al., 2020; Kuang et al., 2018). Research suggests that products made from recycled materials, such as recycled paper and construction materials, contain both higher concentrations of chemicals and a more diverse range of chemicals (Lowe et al., 2021). An example of risk management in this area is recent EU action to restrict the concentration of polycyclic aromatic hydrocarbons (PAHs) in recycled rubber granules used in synthetic turf pitches to protect human health (ECHA, 2019). Looking at circularity in water use, pollutants in urban wastewater and sewage sludges complicate the re-use of wastewater and the spreading of sewage sludge on land. Such practices can disperse micropollutants from consumer products washed down the drain, such as cosmetics, synthetic microfibres, cleaning products and pharmaceuticals (EEA, 2022d), and contaminate agricultural soils — posing risks to human health via dietary exposure (EEA, 2022a).

To avoid human exposure not anticipated under the risk assessment completed for a first use cycle, multiple use cycles should be considered under chemical risk assessments (Wang and Hellweg, 2021). Making chemicals safe and sustainable by design and eliminating non-essential uses of hazardous chemicals could clean up material flows as Europe moves further towards circularity.

How the chemical system impacts ecosystems and human health

Chemical pollution degrades ecosystems, reduces biodiversity and affects the ecosystem services that provide clean drinking water and enable food production. Pollution is of particular concern when hazardous substances are persistent, bioaccumulative and mobile — leading to their widespread distribution in environmental media and their bioaccumulation in living organisms.

The recently published EEA zero pollution monitoring assessment (EEA, 2022a) highlights the key ways in which chemicals impact ecosystems and human health. For instance, the assessment shows that people’s health is being adversely affected by hazardous chemicals that pollute our bodies. Children are particularly vulnerable to the effects of chemicals. There are also positive developments; Europe has been maintaining and improving its bathing and drinking water quality and reducing the risk of antimicrobial resistance. Encouraging trends are taking place in reducing pesticide use, although any resulting positive impact on the environment is yet to be seen.

Exceeding planetary boundaries for chemical pollution

Chemical pollution can exert long-term adverse effects on ecosystem functions and biodiversity at the global scale, and alter the vital Earth systems on which human life depends (Persson et al., 2022; Diamond et al., 2015; Kosnik et al., 2022; Brack et al., 2022). Several examples of chemical impacts at a global scale are presented below.

- Persistent organic pollutants disperse globally, bioaccumulate in ecosystem food chains and have been detected in people across the world. For example, per and polyfluorinated alkyl substances (PFAS) are transported over large distances via atmospheric and hydrological cycles, affect regions far from where they were produced or used, and have been detected in human bodies on all continents of the world (Fiedler et al., 2021).
- Plastic pollution of marine and terrestrial environments is ubiquitous and effectively irreversible, given that plastic does not chemically degrade in the environment but rather fragments. Once ecosystems are polluted with microplastics, it is virtually impossible to remove them (Villarrubia-Gómez et al., 2018).
- While antimicrobial resistance emerges locally, the rapid spread of resistant bacteria, viruses, fungi and parasites through international travel and trade presents a serious health concern at the global level (MacLeod et al., 2014).
- The depletion of stratospheric ozone caused by emissions of ozone-depleting substances (ODS) created holes in the ozone layer over the Arctic and Antarctic and caused global concern in the late 1970s and early 1980s. The subsequent ban on ODS under the Montreal Protocol led to a fall in the consumption of ODS at global level of 99% over the period 1986-2020 (EEA, 2022e). The ozone layer is expected to recover by around 2066 in the Antarctic and around 2045 in the Arctic (World Meteorological Organization, 2022). However, the substitution of ozone-depleting hydrochlorofluorocarbons (HCFCs) with hydrofluorocarbons (HFCs) is an example of regrettable substitution: HFCs subsequently proved to be very potent greenhouse gases, as well as being extremely long-lived in the atmosphere. HFC consumption is now also regulated under the Kigali Amendment to the Montreal Protocol, whereby countries have committed to an HFC phase-down (EEA, 2022f).

Given the potential to affect Earth systems that are essential for human survival, ‘chemical pollution’ was included as one of nine planetary boundaries within which humanity can safely operate (Rockström et al., 2009). A recent assessment found that the production volume, diversity and releases of chemicals at the global level have increased rapidly and exceed societies’ ability to assess and manage the associated risks. The authors recommend urgent action to **reduce the production and releases of chemical pollution**, noting that even if this were to happen, persistent chemicals already in our environment will continue to present risks (Persson et al., 2022). The diversity and quantity of synthetic chemicals produced and released into ecosystems have been increasing at rates greatly surpassing those of other drivers of global environmental change, such as rising atmospheric CO_2 concentrations, nutrient pollution, habitat destruction and biodiversity loss (Bernhardt et al., 2017).

Strengthening Europe's chemicals management — the Chemicals Strategy for Sustainability

In 2020, the European Commission published the Chemicals Strategy for Sustainability, setting an ambitious and progressive roadmap for managing chemical risks in Europe. In line with the precautionary principle, the strategy aims to ban the most harmful chemicals in consumer products — allowing their use only when essential. Key elements in the strategy specifically aim to tackle the risks posed by high volumes and the diversity of chemicals in an efficient and timely manner. These elements will overcome the weaknesses of past time-consuming processes designed to assess and manage the risks related to single substances.

First, broader application of a **generic approach to risk management** would make it simpler and faster to protect people from hazardous chemicals. This involves banning the use of specific chemicals due to their hazardous properties and the types of exposure they are associated with, such as widespread use or exposure to children. Proposed changes would ensure that consumer products — including food contact materials, toys, childcare articles, cosmetics, detergents, furniture and textiles — do not contain chemicals that cause cancers or gene mutations, affect the reproductive, endocrine, immune, neurological or respiratory systems, are toxic to a specific organ, or are persistent and bioaccumulative. Implementing a generic approach will require revising various pieces of existing EU legislation, including REACH, as well as the Food Contact Material Regulation, the Cosmetic Products Regulation and the Toy Safety Directive.

In the meantime, the European Commission has also committed to **grouping chemicals** for risk management (rather than regulating them one-by-one) to expedite protection. In 2022, the Commission published their Restrictions Roadmap under the Chemicals Strategy for Sustainability as a step towards this goal.

To ensure the protection of both humans and the environment from chemical mixtures, a **mixture assessment factor** in chemical risk assessment is foreseen. This should be accompanied by provisions to account for mixture effects in other relevant policies, such as legislation on water, food additives, toys, food contact material, detergents and cosmetics.

Arguably, the most ambitious and important goals of the Chemical Strategy for Sustainability are transitioning to chemicals that are **safe and sustainable by design** and ensuring that the most harmful chemicals are only used when necessary by implementing the **essential use concept**. These upstream measures have the potential to drive a transition in how chemicals are produced and used across society and to support the zero pollution ambition of no harm to the environment and health by 2050.

Safe and sustainable by design

The chemicals strategy for sustainability aims to establish Europe as a frontrunner in the transition to producing and consuming chemicals that are **safe and sustainable by design**. The objective is to harness the innovative capacity of the chemical industry to provide technologies, materials and products that are non-toxic, low-carbon and fit for circularity. Preventing chemical pollution upstream would reduce the need for downstream control on emissions along the chemical life cycle and **reduce chemical pressures** on ecosystems and health. It would, over time, eliminate hazardous chemicals from products and clean up material flows. Ensuring that material flows are non-toxic is key to scaling up the **circular economy** and **ensuring safety for workers and consumers**, in a context where hazardous chemicals in waste present a major barrier to mechanical recycling (ChemSec, 2021). Ensuring that chemicals are **low carbon** throughout the whole life cycle would profoundly challenge the current dependency between the chemical industry and the fossil fuel industry and demand significant innovation to identify alternative feedstocks and processes.

Industry will be a key player in the production and use of safe and sustainable chemicals. Implementing approaches that are safe and sustainable by design entails assessing product performance against requirements for safety and sustainability at the design phase of product development. During the design phase, product engineers have more flexibility to innovate to meet performance objectives for safety and sustainability — compared to evaluating and attempting to implement change once products are already finalised (EEA, 2021d). The transition will take time, as there is a need to develop and harmonise methodologies, to provide training across industrial sectors, to finance implementation and not least to enable innovation for developing safe and sustainable chemicals and materials. The European Commission has recently established a Strategic Research and Innovation Plan for safe and sustainable Chemicals and Materials. The plan guides research and innovation funders and identifies priority areas in their fields to accelerate the transition to chemicals and materials that are safe and sustainable.

In terms of progress, a recent report from the Joint Research Centre presents a methodological framework for defining safe and sustainable by design criteria for chemicals and materials, and potential mechanisms for implementation (Caldeira et al., 2022). Stakeholders from the chemical industry (CEFIC, 2022b) and the NGO community (ChemSec, 2021b) have also proposed guidance and criteria. In tandem, the European Commission is running a multi-stakeholder process to define safe and sustainable by design criteria for chemicals and materials. The recent Commission recommendation establishing a European framework for ‘safe and sustainable by design’ chemicals and materials encourages innovation to replace hazardous substances in products and processes, develop new chemicals and materials, and optimise or redesign production processes and the use of substances currently on the market to improve safety and sustainability (EC, 2022b).

Essential use

The concept of essential use is not new: it was first implemented under the Montreal Protocol on Substances that Deplete the Ozone Layer (see Decision IV/25.19) to identify substances to be subject to control measures. The two elements of essential use under the Montreal Protocol are that:

- a use is ‘necessary for health, safety or is critical for the functioning of society’; and
- that ‘there are no available technically and economically feasible alternatives’.

Under the chemical strategy for sustainability, the European Commission committed to **phasing out non-essential societal uses of the most harmful substances**, particularly in consumer products. The aim is to ensure that the most harmful chemicals are only used if necessary for **health**, **safety** or if **critical for the functioning of society** and if there are **no acceptable alternatives** from the standpoint of environment and health. Regarding specific groups of chemicals, the strategy aims to ensure that:

- endocrine disruptors are banned in consumer products as soon as they are identified, unless they are proven essential for society;
- the use of PFAS is phased out in the EU, unless it is proven essential for society.

Application of the essential use concept is intended to encourage innovation in safe and sustainable chemicals, providing alternatives to the most harmful substances with the overall aim of cleaning up material flows, cutting pollution and ensuring consumer safety. Clear criteria on what constitutes an essential use could support a more systematic, transparent and efficient assessment of derogations to restrictions and authorisations under REACH, providing greater regulatory certainty (Wood E&IS GmbH, 2022). Hence, the Commission is tasked with defining **criteria for essential use** meant to guide the coherent application of essential uses across all relevant EU legislation for both generic and specific risk assessments. In March 2022, the Commission consulted stakeholders on the concept of essential uses and how it might be operationalised in REACH and other chemicals legislation, with the results summarised in a workshop report.

It is crucial that the concept of essential use focuses on the **uses or function of a chemical within a product** (be it a mixture, article, process or service), and neither on the individual chemical nor the product. Chemicals are used to deliver a functionality, and it is rare that a specific functionality can only be achieved by one chemical or class of chemicals. If that chemical is identified as harmful, then the substance should be substituted with a chemical or non-chemical alternative. Identifying certain chemicals as generically ‘essential’ could lead to lock-ins, inhibiting innovation. The assessment of essentiality is not permanent and may be revisited over time (Cousins et al., 2021; Wood E&IS

GmbH, 2022).

To ensure a focus on use and a broad exploration of alternatives, one proposal is to marry the essential use concept with a **functional substitution concept**. This starts with the functional use of a chemical of concern, evaluates if the function is necessary for the application, and then examines whether a safer and more sustainable chemical, product, process or service exists that could fulfil that function. The aim is to encourage innovators to look beyond chemical substitution to other aspects of product design or service delivery. This raises the question of what level of performance should be fit for purposes, supposing that sometimes, lower levels of product performance may need to be accepted to deliver products that are safe and sustainable (Roy et al., 2022). Finally, the consideration of essential use is not a purely technical discussion, but should also consider societal perceptions on what uses and functions are essential.

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