European Environment Agency

Europe's environment 2025 - Main report

Europe's environment and climate: knowledge for resilience, prosperity and sustainability

EEA Report

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

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Foreword

As we move into the final stretch of the 2030 Agenda for Sustainable Development, we see profound disruption and increasing complexity across the globe. The visibly changing climate, technological upheaval, geopolitical fragmentation, along with conflicts in Ukraine and elsewhere, are testing the foundations of international cooperation and domestic resilience.

This has brought security, preparedness and competitiveness to the forefront of Europe's strategic agenda. As this report demonstrates, each of these priorities is intertwined with environmental sustainability.

Despite the transformative ambition of the European Green Deal, which represented a paradigm shift in terms of environmental legislation and policy frameworks, underlying sustainability trends remain largely unchanged. The window for meaningful action is narrowing, and the consequences of delay are becoming more tangible. We are approaching tipping points — not only in ecosystems, but also in the social and economic systems that underpin our societies.

Delivering on the ambitions of the European Green Deal requires not only political will, but also institutional capacity, societal engagement, and a commitment to evidence-based decision-making. Europe needs integrated responses that reflect the interconnectedness of climate, environment, economy, health and security.

In a time of flourishing misinformation, alternative truths and declining trust in public authorities, scientific data, knowledge, and monitoring are more vital than ever, to track progress, identify gaps, and guide course corrections. *Europe's environment 2025* reflects this need. It offers a comprehensive assessment of Europe's environmental state and outlook, with a new structure and approach which responds to today's realities.

This seventh edition is the result of deep collaboration with all 38 EEA member countries. We gratefully acknowledge the contributions of our Eionet country network and European Topic Centres — together, we are in a unique position to deliver trusted, pan-European knowledge. We also thank the many stakeholders who engaged with us throughout this process, enriching the report with diverse perspectives and expertise.

Our hope is that *Europe's environment 2025* reaches and resonates with its audiences: EU policymakers, national and regional actors, civil society and citizens. In these uncertain times, it should serve as a solid knowledge base and a catalyst for the urgent action needed to move closer to our shared vision — to live well, within the limits of our planet. The future is ours to shape.

Leena Ylä-Mononen
Executive Director
European Environment Agency

About *Europe's environment 2025*

Every 5 years, as mandated in its founding regulation, the European Environment Agency (EEA) publishes its flagship product on the state of Europe's environment (previously known as SOER). It provides decision-makers at the European, national, regional and local levels, as well as the general public, with a comprehensive and cross-cutting assessment of the environment, climate and sustainability in Europe.

Europe's environment 2025 draws on the latest scientific evidence and is underpinned by the most comprehensive data on the environment, climate and sustainability available in Europe. The data come from 38 countries (European Union (EU) and non-EU), and have been quality-assured and validated by the EEA. Based on that robust and reliable foundation, *Europe's Environment 2025*:

- presents past trends and provides outlooks on a wide range of environment and climate topics;
- highlights key pressures and drivers of change;
- flags challenges and emerging issues; and
- provides insights into and case studies about potential responses to Europe's sustainability challenges.

Europe's environment 2025 is the seventh edition since 1995. It is based on and fully aligned with other recent key publications by the EEA such as the *Accelerating the circular economy in Europe*, *European Climate Risk Assessment*, *Europe's state of water*, *Zero pollution monitoring and outlook*, *Monitoring report on progress towards the 8th EAP objectives*, *Renewables, electrification and flexibility — For a competitive EU energy system transformation by 2030*, *Sustainability of Europe's mobility systems*, and *Trends and projections in Europe*.

Europe's Environment 2025 comprises three main parts:

- **Thematic briefings** provide concise and comparable overviews of past trends, and outlooks to 2030. They also include assessments of prospects for meeting EU policy targets for 35 topics on the environment and climate, as well as enablers for a green transformation.
- **Country profiles** provide concise, country-level assessments written by the countries themselves. They focus on key national trends around the environment and climate, socio-economic developments and changes in relation to energy, mobility and food. The country profiles have been co-developed by the EEA and its European Environment Information and Observation Network (Eionet) and are based on 20 established EEA or Eurostat indicators and have been fact-checked by the EEA. They are not an assessment of progress by the EEA or European Commission (EC) but an assessment drafted by the countries on their main trends around sustainability, the challenges around them and the measures they are adopting. As such, they complement the Environmental Implementation Review country reports 2025 prepared by the EC.

- **This report**, *Europe's environment and climate: knowledge for resilience, prosperity and sustainability*, provides a dynamic understanding of how the environment and climate meet people's needs, anchored in the EU's visions for a sustainable Europe by 2050. Its six chapters build on the overview of past trends and prospects for progress in the thematic briefings.

    - **Chapter 1 'Building European resilience in an unstable world'** introduces the challenges posed by the unprecedented pressures on the Earth's life support systems in combination with geopolitical ruptures. It covers EU responses to these challenges and highlights the urgency to transform our key production and consumption systems.

    - **Chapter 2 'The evolving European policy framework'** describes the current policy architecture aimed at delivering a fair and green transformation. It focuses on the current political priorities and aspirations of the EC, as well as providing an overview of the environment and climate legislation previously agreed under the European Green Deal (EGD).

    - **Chapter 3 'Europe's environment and climate: state and outlook'** assesses the current state of the environment and climate in Europe including an assessment of past trends, outlooks and progress towards policy targets. The assessment is structured around three blocks of content: ecosystems and biodiversity, climate change mitigation and adaptation, and pollution and environmental health.

    - **Chapter 4 'Managing the dynamic between our economy and our natural resources'** explores competing priorities for natural resources in Europe with a focus on land, water and raw materials, and how these are foundational for a resilient economy and society. It also assesses progress towards a circular economy in which EU resource consumption is decoupled from economic growth.

    - **Chapter 5 'Delivering on people's needs: Europe's production and consumption systems'** explores Europe's key production and consumption systems — food, energy, mobility, the built environment and industry — in terms of progress made in transforming these systems towards sustainability and in relation to remaining challenges. This is illustrated through a range of examples from across EEA member countries.

    - **Chapter 6 'A cause for hope: levers of transformative change'** considers a range of levers for change — policy levers, socio-technological levels and economic levers — and demonstrates how initiatives and actions successfully applied across EEA member countries can enable and accelerate progress towards sustainability. Aspects covered are the role of policy implementation and coherence; innovation; finance; skills and jobs; and governance.

Executive summary

Europeans face turbulent times. Multiple economic, social, geopolitical and environmental crises are converging to pose systemic risks to our way of life. Europe is warming twice as fast as the global average, with extreme weather events driven by climate change impacting people's lives across Europe today. At the same time, political realities across the world have undergone a seismic shift, and Russian's war of aggression against Ukraine and other armed conflicts have focused minds and investments on defence and security.

The European Union (EU) has responded to this volatile and insecure global context through its strategic policy framework to 2029 — the Competitiveness Compass. The three areas for action set out in the compass — innovation, decarbonisation and security — all have strong environment and climate dimensions, with clean industry, energy system transformation, circular economy and reducing import dependencies as key priorities.

Indeed, Europe is critically dependent on natural resources for economic security, to which climate change and environmental degradation pose a direct threat. Protecting our natural resources, mitigating and adapting to climate change, and reducing pollution will build the resilience of vital societal functions that depend on nature, such as food security, drinking water and flood defences. The European Preparedness Union Strategy recognises the potential for risks to cascade between the natural, social and political domains in the context of extreme weather events, human-induced disasters and geopolitical crises. Europe must stay on course with its green ambitions and implement the environment and climate policies agreed under the European Green Deal (EGD) to achieve its long-term vision of 'living well within the limits of our planet'.

In this context, *Europe's environment 2025* provides the most comprehensive picture of the environment, climate and sustainability available in Europe, building on data from across 38 countries. Figure ES.1 summarises the results of this comprehensive assessment.

Overall, important progress is taking place within climate change mitigation, while there is mixed progress around reducing pollution and transitioning towards the circular economy. The greatest challenges exist around reducing biodiversity loss and ecosystem degradation, as well as adapting to accelerating climate change. However, progress on a range of factors that enable the shift towards sustainability – such as innovation, green employment and sustainable finance - gives cause for hope.

This executive summary unpacks these key trends and highlights insights from across the three products in *Europe's environment 2025*; the 35 thematic briefings; the 38 country profiles; and this report.

Biodiversity is declining across terrestrial, freshwater and marine ecosystems in Europe due to persistent pressures driven by unsustainable production and consumption patterns, most notably the food system. Key pressures include changes in land and sea use, the over-exploitation of natural resources, pollution and invasive alien species, as well as the increasingly severe impacts of climate change.

More than 80% of protected habitats are in a poor or bad state, with 60-70% of soils degraded. In terms of past trends, the 2020 target of the EU Biodiversity Strategy — to halt and reverse biodiversity loss — was not achieved. Figure ES.1 shows deteriorating past trends or a mixed picture across thematic areas.

On a positive note, the extent of protected areas increased over the past decade. By 2022, 26.1% of the EU's land and 12.3% of its seas were protected. While this expansion is promising, designating protected areas alone does not guarantee that biodiversity is effectively protected.

Looking ahead, the deterioration in the state of Europe's biodiversity and ecosystems is expected to continue, with future policy objectives unlikely to be met (Figure ES.1).

The degradation of our natural world jeopardises the European way of life. Healthy ecosystems underpin food and water security and supply raw materials, water and energy to the production and consumption systems that deliver our food, mobility, housing, energy and goods.

Ecosystem degradation and climate change also threaten financial stability, with close to three-quarters of businesses producing goods and services in the euro area being critically dependent on ecosystem services. A loss of services such as water supply, healthy soils or pollination impacts production and translates into financial risk, while floods, droughts and forest fires can damage assets. Companies also face transition risks whereby they must adapt to a changing legal landscape and new market conditions. This is in a context where 75% of bank loans in the euro area are granted to companies dependent on natural resources.

Europe's water resources are under severe pressure; water stress currently affects 30% of Europe's territory and 34% of the population. Only 37% of Europe's surface water bodies had a good or high ecological status in 2021, with the degradation of aquatic ecosystems threatening Europe's water resilience.

Agriculture is responsible for the most significant pressure on both surface and groundwater. Fertiliser and pesticide runoff degrade water quality, promoting excessive algae growth, deplete oxygen levels and drive the loss of aquatic life.

Clean water is crucial for ecosystems and human health, and is a vital resource for agriculture and industry, as well as energy infrastructure and inland transport. The security and supply of clean water is affected by pollution, over-abstraction and physical changes to water bodies. Climate change is only exacerbating these issues. Maintaining healthy aquatic ecosystems, protecting watersheds and ensuring that groundwater resources are replenished is crucial to ensuring Europe's future water resilience.

Important progress has been made towards mitigating climate change, with the EU being a world leader in this area. The EU has successfully cut its domestic greenhouse gas (GHG) emissions by 37% since 1990, largely driven by reducing fossil fuel use and doubling the share of renewables since 2005.

This demonstrates how climate action can boost competitiveness and energy security by lowering dependence on imported fossil fuels and increasing the share of domestically produced renewable energy. It also shows how effective policy implementation can drive change and deliver measurable progress towards sustainability and achieving climate neutrality by 2050.

Progress on climate change mitigation is reflected in Figure ES.1. The past trend shows an improving picture and projected reductions put the EU on track to meet its 2030 goal of reducing net GHG emissions by at least 55% compared to 1990 levels.

The EU's carbon sink related to land use, land use change and forestry has declined by about 30% compared to the last decade. This is due to a combination of factors such as ageing forests, more frequent and widespread tree felling, and the increasing impacts of climate change and severe natural disturbances, including forest fires, droughts and pests.

A wide variety of options exist to reverse this trend and enhance carbon removals in terrestrial ecosystems, with significant environmental and societal co-benefits. Adequate finance and improved monitoring will be key to enabling land practitioners to adopt changes in their management practices.

In the energy system, all EU Member States have successfully reduced their reliance on fossil fuels and shifted towards more sustainable energy sources over the last decade, while increased energy efficiency has also brought down demand. In 2023, renewable energy sources represented over 24% of the EU's final energy use. This represents a historic high driven by EU policies to speed up the clean energy transition, including the European Climate Law, the Fit for 55 EU policy package and the REPowerEU plan.

Nevertheless, fossil fuels remain the dominant source of energy — making up almost 70% of EU gross available energy use in 2023. Further investment is needed to accelerate the deployment of renewables and enable a deeper transformation of the European energy system.

Clear regulatory signals reinforced with consistent pricing can make low-carbon and circular choices cheaper, with the phase-out of fossil fuel subsidies crucial to decarbonisation.

There has also been progress in the EU's industrial system, where GHG emissions fell by more than 35% from 2005 to 2023. Further decarbonisation will require large-scale electrification, a switch to hydrogen for certain industrial processes and the substitution of fossil fuel-based materials with renewable materials.

Cuts in air emissions from industry have been driven by decades of pollution control legislation, as well as decarbonisation measures. Nevertheless, industry remains a major contributor to air pollution and the costs of industrial pollution are substantial. In 2021, they stood at EUR 353 billion in 2021 and mostly related to impacts on people's health.

To achieve further gains, a deeper industrial transformation entailing the deployment of more advanced, innovative techniques and circularity measures offer promising synergies between decarbonisation, zero pollution and resource efficiency.

In the built environment, GHG emissions from EU buildings also fell by more than 35% between 2005 and 2023. This progress was driven by higher energy efficiency standards for new buildings and the decarbonisation of the electricity and heating sectors. Energy-efficient renovation, climate-resilient buildings and the adoption of more circular economy models are necessary to ensure that the EU building stock is fit for 2050.

In contrast, the picture for the mobility system and the food system remains challenging. Mobility in Europe is dominated by vehicular transport, with passenger cars responsible for more than 75% of transport activity in Europe. The sector

remains heavily dependent on fossil fuels. While emissions from the transport sector have decreased, the change has only been marginal over the last decade. In 2023 GHG emissions from domestic transport were only 6% below the 2005 level.

Similarly, GHG emissions from agriculture only decreased modestly, with a 7% reduction since 2005. Agriculture accounts for 93% of EU ammonia emissions to air and is the main driver of pollinator decline and soil degradation. As such, it undermines the very ecosystem services upon which it depends.

At the same time, Europe is the fastest-warming continent on the planet; our climate is changing at an alarming rate, threatening security, public health, ecosystems, infrastructure and the economy. Downpours are increasing in severity, with several regions subject to catastrophic floods in recent years. In 2023, floods in Slovenia resulted in a 16% loss in gross domestic product. Meanwhile, in 2024 floods in Valencia caused over 250 fatalities.

Southern Europe is plagued by water scarcity and wildfires, with droughts impacting food production, the energy sector and public water supply. Extreme heat, once rare, is becoming more frequent, with deadly consequences: over 70,000 people in Europe are estimated to have died from heat in 2022. Over 240,000 fatalities have been caused by weather- and climate-related extreme events between 1980 and 2023 in the EU-27.

Weather- and climate-related extremes caused economic losses of assets estimated at EUR_{2023} 738 billion in the 27 Member States of the EU over the period 1980-2023, with over EUR_{2023} 162 billion in costs from 2021 to 2023 alone.

As climate change accelerates the costs are growing, with the average annual economic losses associated with weather- and climate-related extremes in the 2020-2023 period being 2.5 times as high as in the preceding decade from 2010 to 2019. At the same time, the insurance protection gap across Europe is substantial — with most countries reporting over 50% of losses as uninsured. The gap has also been widening over time, as uninsured losses have grown at a faster rate than insured losses.

Changing growing conditions and extreme weather events, particularly reduced water availability and quality, present risks to Europe's food security, with southern Europe particularly hard hit. In 2022 and 2023, severe drought in parts of Europe led to considerable agricultural losses that translated into higher food prices for consumers.

Looking forward, there is an urgent need for Europe's agricultural sector to adapt to extreme weather events to guarantee the EU's long-term food security. There is a role for biodiversity in providing solutions for adaptation to changing climatic conditions for food production in Europe, for example as a source of drought-resistant species.

The increasing frequency and magnitude of climate-related disasters, as well as the knowledge that the climate will continue to change even with the EU's ambitious mitigation efforts, underscores the urgent need to adapt European society and the economy, while at the same time ensuring that no one is left behind. Socially vulnerable groups, such as older people, children, low-income groups and people with disabilities, are disproportionately burdened by climate change and do not always benefit fairly from adaptation responses.

Action is needed to ensure that choices taken today are fit for the future climate, for example in areas like land-use planning and long-lived infrastructure. It is essential to identify the assets at risk from climate-driven extreme weather events and develop

strategies that will build social resilience to climate change. Currently, around 12% of the European population lives in flood-prone areas, while 11% of healthcare facilities and nearly 15% of industrial facilities in Europe are sited in such areas.

In terms of economic vulnerability to climate change, there is an urgent need for actors in the real economy to assess exposure to climate risks along their value chains and to develop adaptation strategies. Likewise, the financial sector must take climate-related risks into account in their risk management frameworks and foster transparency around climate-related and environmental disclosures.

The EU has already made considerable progress in understanding climate risks. In this context, the European climate adaptation plan, expected in 2026, will be a key opportunity to integrate these concerns into national adaptation processes, strategies and plans. Meanwhile the EU Preparedness Union Strategy aims to enhance climate adaptation and ensure access to critical natural resources such as water and food.

All EU Member States have a national adaptation policy in place and many have regional or sectoral adaptation policies or action plans. Likewise, the number of sub-regional authorities with adaptation plans in place has also increased substantially over the past decade.

Despite these well-developed governance frameworks, implementation of adaptation measures lags substantially behind the rapidly increasing risk levels. This is due to challenges related to regional and local coordination and limitations in financial, technical and human capacities.

Significant progress has been made in reducing pollution in Europe. EU policies to improve air quality have saved lives, with a 45% reduction in premature deaths attributable to fine particulate matter from 2005 to 2022. The vast majority of people also now benefit from access to clean drinking water and sanitation.

Nevertheless, pollution continues to reduce quality of life in Europe significantly; millions of years of healthy life are still lost each year due to pollution and at least 10% of premature deaths in Europe are driven by exposure to polluted air, water and soil, noise and harmful chemicals. Air pollution drives at least 239,000 premature deaths annually, while noise pollution is behind 66,000 premature deaths.

Evidence from human biomonitoring studies shows that a large share of the EU population has unsafe levels of toxic chemicals in their bodies. Meanwhile, many European waters are contaminated with per- and poly-fluoroalkyl substances above EU limit values.

The greatest impacts from environmental risks to health fall on socio-economically deprived groups and vulnerable groups such as children, the elderly, the chronically ill and people with disabilities. Addressing the unequal distribution of environmental risks across European society is an important dimension of social fairness. In this context, it is clear that tackling pollution prevents death and disease, reduces productivity losses due to ill health, cuts healthcare costs and fosters societal resilience.

Trends in environmental and human health are expected to show a mixed picture going forward, with policy objectives for reducing environmental noise and water pollution unlikely to be met (Figure ES.1).

Increasing environmental pressures, together with geopolitical instability, make it vital to rethink how we source and consume natural resources. The circularity agenda fosters an economy where primary resource use and waste generation are low and products and materials are recirculated for further use.

However, Europe only slightly increased its circularity rate, from 10.7% in 2010 to 11.8% in 2023. This indicates that linear systems still prevail in Europe. Nevertheless, there are positive trends in Europe towards a more circular economy, with the share of waste recycling increasing and resource efficiency improving over the past 10-15 years. There is also progress towards financing circularity (Figure ES.1). Opportunities exist to improve the quality of recycling, bolster demand for recycled materials and cut costs through a single market for waste, secondary raw materials and reusable materials in the EU.

Looking ahead, while the outlook for waste recycling, circular design and sustainable production is positive, the EU is only partially on track to meet its policy targets. It is also unlikely to meet the 2030 objective of doubling the circular use of materials (Figure ES.1).

Material consumption within the EU is unsustainable and much higher than in most other world regions per person. Beyond technical measures to ensure that materials remain in circulation in the economy for longer, there is an urgent need to reduce the demand for materials and energy from Europe's key production and consumption systems.

International supply chains mean that much of the environmental degradation driven by the extraction, processing and use of resources to fuel EU consumption occurs outside the EU. At the global level, resource extraction has tripled over the past 50 years and continues to rise.

Efforts to reduce the EU's material footprint should address the demand for resources along the entire value chain. In this context, implementing the Regulation on deforestation-free products will be an important step towards bringing down GHG emissions and biodiversity loss linked to EU consumption.

Transformative change to production and consumption systems — decarbonising the economy, shifting towards circularity, reducing pollution and exercising responsible stewardship of natural resources — is urgently required to maintain prosperity and living standards in Europe over the long term. Today, EU policies provide a clear pathway towards sustainability, with the focus now falling on implementing legislation agreed under the EGD in an effective and timely manner.

Local and regional authorities are playing a critical role in implementing environment and climate legislation and translating policies into change on the ground. Transforming the EU's production and consumption systems requires coordinated policies and action across multiple levels of governance. Across Europe, communities are increasingly taking action to become sustainable, with examples of good practice seen across the food, energy and housing sectors, as well as climate change adaptation.

Efforts to restore habitats through nature-based solutions will, over time, build resilience in natural systems and enable both adaptation to and mitigation of climate change. The Nature Restoration Regulation aims to restore at least 20% of the EU's land and sea areas by 2030; in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters.

Healthy ecosystems help stabilise the climate at the global scale and build resilience at the local scale. Forests, wetlands, peatlands and oceans act as carbon sinks helping mitigate climate change and regulate the Earth's temperature. Wetlands and floodplains provide natural flood protection, forests and urban green spaces help mitigate the effects of heatwaves and healthy soils enhance water retention, reducing the risks of droughts and avalanches.

Increasing circularity and decarbonising production have the potential to reduce our dependencies on imports of energy and materials and therefore enhance Europe's strategic autonomy. By investing in the digital and green transition of European industry, Europe can become a global leader and a first mover in developing technologies to decarbonise hard-to-abate industries, in particular steel and cement.

The EU has set the goal of bolstering the rapid deployment of technological innovations to gain competitive advantage. Indeed, Europe is already a world leader in green innovation, with the EU and other European countries already account for almost 27% of cleantech international patent families from 2017 to 2021. Weaknesses in the innovation ecosystem and a fragmented Single Market currently present obstacles to commercialisation, however. Despite the challenges, Europe is building the foundation for the supply of clean and green sustainable products, as well as stimulating demand and fostering lead markets.

This approach forms a key tenet of Europe's economic strategy — competitiveness — as well as supporting sustainable prosperity that rests on a high-quality environment delivering healthy ecosystem services — the fundament basis upon which the economy operates.

Among European businesses and companies, there is a growing recognition that a failure to account for, mitigate and adapt to nature and climate risks threatens business models and financial stability. Increasingly, financial institutions are starting to take a strategic, forward-looking and comprehensive approach to managing such risks. In the EU, companies have started using the Taxonomy to plan and highlight their green investments, with around 20% of companies' capital investments aligned with the Taxonomy in 2023. Some first mover companies have also started to shift from a conventional approach of compliance with minimum standards to a reinvention of their business model to prioritise decarbonisation and circularity.

European businesses still need to deliver in terms of economic performance, added value and job creation while being embedded in the global economy, with its international markets and competition. In this context, the Carbon Border Adjustment Mechanism aims to combat carbon leakage, aligning the carbon prices of goods imported into the EU with domestically-produced goods. Carbon leakage occurs when companies based in the EU move carbon-intensive production abroad to countries where less stringent climate policies are in place than in the EU, or when EU products get replaced by more carbon-intensive imports. The idea is to establish a level playing field and bolster EU competitiveness. At the same time, the mechanism aims to encourage cleaner industrial production in third countries, as low-emission goods will benefit from a price advantage.

Europe's competitiveness depends not only on the price, quality and sustainability of products but also on the resilience of European society. Employment in the environmental goods and services sector is growing at a faster rate than the EU's overall employment rate. The expansion of the renewable energy sector has contributed to a boost in green jobs in Europe, while projections for other sectors and industries indicate that there is potential for high job creation through green investments. Boosting employment will depend on green skills development in education and training policies to align the labour market with business needs.

In this context, understanding that a healthy environment underpins our future prosperity is critical to ensure the necessary long-term investments to protect our biodiversity and ecosystems and adapt to and mitigate climate change. Building intergenerational fairness into decision-making can address short-termism in policy making. The European Commission is seeking to strengthen communication across generations through citizen engagement and a series of dialogues with young people.

Looking ahead, Europe's sustainability challenges remain complex and systemic. Despite successes, especially in mitigating climate change and reducing pollution, the outlook for most environmental trends is concerning and inextricably intertwined with Europe's economic prospects, security and quality of life.

This calls for a need to rethink the way the relationship between our economy and the natural environment — land, water and natural resources — is managed in the face of competing interests. Only by restoring the natural environment in Europe will we be able to maintain a high quality of life for European citizens.

A profound shift towards responsible stewardship of our natural capital is urgently needed to ensure that we can meet people's needs today without sacrificing those of future generations.

The results of the assessments of the state and outlook across 35 thematic areas are presented in Figure ES.1 below. Topics cut across biodiversity and ecosystems, climate change, environment and human health and circular economy and other cross cutting enablers. Full assessments are available in the thematic briefings of *Europe's environment 2025*.

Figure ES.1 **Summary of (a) past trends, (b) outlooks, (c) progress towards 2030 EU policy targets (d) progress towards 2050 EU policy targets**

(a) Past trends

The assessment of past trends covers the last 10-15 years, typically based on data from around 2010 onwards. In exceptional cases, the trend is assessed over a longer period, such as for greenhouse gas emissions where the trend looks back to 1990.

The assessment is based on expert judgement of available evidence, including both quantitative indicators and qualitative information. The assignment of a colour to indicate the direction of trends is therefore qualitative, rather than being based on a statistical method.

Past trends (10-15 years)

Biodiversity and ecosystems	Climate change	Environment and human health	Circular economy and other enablers of transformative change
State of Europe's biodiversity	Greenhouse gas emissions	Emissions of pollutants to air	Circular design and sustainable production
Pollution of ecosystems	Trends in the mobility system	Air pollution and impacts on human health	Waste generation and material consumption
Protected areas	Trends in the energy system	Environmental noise and impacts on human health	Waste recycling
Water and climate impacts	Carbon dioxide removal from the atmosphere	Water pollution and human health	Circular use of materials
Ecosystems and climate impacts	Ozone-depleting substances and fluorinated greenhouse gases	Chemical pollution and human health	Circular economy financing and strategies
Land use and land take	Climate risks to the economy	Environmental health inequalities related to air pollution	Benefits of a circular economy
Soil resources	Climate risks to society		Global impacts from EU consumption
Biodiversity investment needs	Climate action financing		Transformative innovation
	Governance of climate change mitigation and adaptation		Green employment
			Green taxation and other economic instruments
			Justice in sustainability transitions
			Financing the transition towards sustainable activities

Improving trends dominate Trends show mixed picture Deteriorating trends dominate

(b) Outlook

The assessment of outlooks asks what the trends are expected to be 10 to 15 years in the future, up to between 2035 and 2040.

Like the assessment of past trends, the outlook is qualitative and combines modelled estimates of future developments (where available) with expert consideration of the likely effects of policies currently in place. The assessment also considers other factors expected to shape future trends, such as societal, technological or economic developments.

Due to the broader scope and the longer time horizon, for some thematic areas the outlook differs in colour from the prospects of meeting 2030 or 2050 EU policy targets.

Outlook (10-15 years)

Biodiversity and ecosystems	Climate change	Environment and human health	Circular economy and other enablers of transformative change
State of Europe's biodiversity	Greenhouse gas emissions	Emissions of pollutants to air	Circular design and sustainable production
Pollution of ecosystems	Trends in the mobility system	Air pollution and impacts on human health	Waste generation and material consumption
Protected areas	Trends in the energy system	Environmental noise and impacts on human health	Waste recycling
Water and climate impacts	Carbon dioxide removal from the atmosphere	Water pollution and human health	Circular use of materials
Ecosystems and climate impacts	Ozone-depleting substances and fluorinated greenhouse gases	Chemical pollution and human health	Circular economy financing and strategies
Land use and land take	Climate risks to the economy	Environmental health inequalities related to air pollution	Benefits of a circular economy
Soil resources	Climate risks to society		Global impacts from EU consumption
Biodiversity investment needs	Climate action financing		Transformative innovation
	Governance of climate change mitigation and adaptation		Green employment
			Green taxation and other economic instruments
			Justice in sustainability transitions
			Financing the transition towards sustainable activities

Improving trends expected to dominate

Trends expected to show a mixed picture

Deteriorating trends expected to dominate

(c) Prospects of meeting 2030 EU policy targets

The assessment focusses on the prospects of meeting 2030 targets and/or objectives in relevant EU policies.

Often several targets have been set to address a particular thematic area, in which case the targets have been clustered under a single assessment.

In cases where no policy targets or objectives are in place for a thematic area, no assessment was made, and the relevant square is grey.

As for past trends and outlook, the assessment is qualitative and based on the extrapolation of trends in quantitative indicators observed over previous years (if available), modelled estimates of future developments (if available) and expert consideration of qualitative evidence.

Prospects of meeting policy targets 2030

Biodiversity and ecosystems	Climate change	Environment and human health	Circular economy and other enablers of transformative change
State of Europe's biodiversity	Greenhouse gas emissions	Emissions of pollutants to air	Circular design and sustainable production
Pollution of ecosystems	Trends in the mobility system	Air pollution and impacts on human health	Waste generation and material consumption
Protected areas	Trends in the energy system	Environmental noise and impacts on human health	Waste recycling
Water and climate impacts	Carbon dioxide removal from the atmosphere	Water pollution and human health	Circular use of materials
Ecosystems and climate impacts	Ozone-depleting substances and fluorinated greenhouse gases	Chemical pollution and human health	Circular economy financing and strategies
Land use and land take	Climate risks to the economy	Environmental health inequalities related to air pollution	Benefits of a circular economy
Soil resources	Climate risks to society		Global impacts from EU consumption
Biodiversity investment needs	Climate action financing		Transformative innovation
	Governance of climate change mitigation and adaptation		Green employment
			Green taxation and other economic instruments
			Justice in sustainability transitions
			Financing the transition towards sustainable activities

Largely on track to meet policy targets

Partially on track to meet policy targets/highly uncertain

Largely not on track to meet policy targets

No quantitative policy targets

(d) Prospects of meeting 2050 EU policy targets

The assessment focusses on the prospects of meeting 2050 targets and/or objectives in relevant EU policies.

Given the long-term time horizon, there are no policy targets or objectives in place for many of the thematic areas, explaining why many of the squares are grey.

The same methodology has been applied as for the assessment of prospects of meeting 2030 EU policy targets (see above).

Prospects of meeting policy targets 2050

Biodiversity and ecosystems	Climate change	Environment and human health	Circular economy and other enablers of transformative change
State of Europe's biodiversity	Greenhouse gas emissions	Emissions of pollutants to air	Circular design and sustainable production
Pollution of ecosystems	Trends in the mobility system	Air pollution and impacts on human health	Waste generation and material consumption
Protected areas	Trends in the energy system	Environmental noise and impacts on human health	Waste recycling
Water and climate impacts	Carbon dioxide removal from the atmosphere	Water pollution and human health	Circular use of materials
Ecosystems and climate impacts	Ozone-depleting substances and fluorinated greenhouse gases	Chemical pollution and human health	Circular economy financing and strategies
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			Green taxation and other economic instruments
			Justice in sustainability transitions
			Financing the transition towards sustainable activities

Largely on track to meet policy targets

Partially on track to meet policy targets/highly uncertain

Largely not on track to meet policy targets

No quantitative policy targets

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1 Building Europe's resilience in an unstable world

Key messages

- Today's global, geopolitical landscape is characterised by multiple crises. In response, Europe is focused on security and defence, as well as boosting competitiveness, to deliver sustainable prosperity and maintain quality of life for European citizens.
- Without environmental resilience, we cannot have long-lasting security. A broad understanding of security captures not only defence, but also the resilience of vital societal functions that depend on our natural environment. Healthy and functional ecosystems underpin food and water security and build resilience to our changing climate. A circular economy and shifting away from fossil fuels help Europe to reduce dependency on imports of raw materials and energy.
- Climate change and pollution impact the lives of Europeans today. From 1980 to 2023, over 240,000 fatalities have been caused by weather- and climate-related extreme events in the EU-27, with more than EUR 730 billion in economic losses. Pollution drives death and disease, with air pollution costing the EU EUR 600 billion annually in health costs and other damages, equal to 4% of GDP.
- Environmental degradation and climate change threaten Europe's economy. Climate change presents a systemic risk to both the economy, with impacts cascading across economic sectors and international borders. Close to three quarters of businesses in the euro area are critically dependent on ecosystem services, while 75% of bank loans are granted to companies that are dependent on natural resources.
- Europe's energy, food, mobilíty and industrial systems currently drive environment and climate impacts. As a world leader on sustainability, Europe has the knowledge, tools and resources to green these systems. Progress towards decarbonisation of the energy system in Europe provides a model for change. The challenge now is to significantly accelerate change across all systems.

1.1 Europe's response to instability in the geopolitical landscape

In 2025, Europe finds itself navigating a global polycrisis that spans geopolitical, economic and environmental domains, driving volatile and unpredictable outcomes. Since Europe emerged from the disruption caused by the COVID-19 pandemic, policymakers have faced overlapping challenges. These include Russia's invasion of Ukraine, hikes in the costs of living and a new political leadership in the United States (US) that is re-evaluating alliances and disrupting long-standing trade policies. At the

same time, the effects of climate change are escalating and severely impacting people's lives across the globe, with Europeans suffering the consequences of droughts, floods, heatwaves and wildfires.

Europe's sustainability agenda is challenged by this increasingly unstable global context. There are currently over 110 armed conflicts taking place across the world(1) and the number of refugees globally is at a record high(2). Russia's invasion of Ukraine triggered a shock to the global economy, pushing up energy and food prices and adding to the inflationary pressures building in Europe following the COVID-19 pandemic, with citizens at risk of poverty and social exclusion worst affected by these factors(3). Heightened geopolitical tensions have translated into geoeconomic tensions, with the introduction of non-tariff measures, tariffs and subsidies, as well as efforts to revitalise national and regional industries and to secure access to strategic resources(4).

Ursula von der Leyen began her second mandate as president of the European Commission in this volatile geopolitical context. Together with a new College of Commissioners, she has defined the priorities for the European Commission (EC) for 2024 to 2029, as laid out in the political guidelines. In response to an atmosphere of uncertainty and instability, the European Union (EU) is focusing on seven key priorities:

- sustainable prosperity and competitiveness;
- security and defence;
- European social fairness;
- quality of life;
- democracy and European values;
- a global Europe; and
- investment and reform.

The political guidelines also emphasise the ongoing importance of delivering on the legislative developments agreed under the European Green Deal (EGD):

> We must and will stay the course on the goals set out in the European Green Deal. The climate crisis is accelerating at pace. And there is an equally urgent need to decarbonise and industrialise our economy at the same time. We must focus on implementing the existing legal framework for 2030 — in the simplest, fairest and most cost-efficient way(5).

In this context, this report provides a science-based assessment of the state of Europe's environment and climate and outlooks towards achieving the EU's 2030 policy goals. It builds on 35 thematic briefings and¬ quantitative assessments of the most recent environment and climate data reported to the European Environment Agency (EEA) by our 32 member countries and six cooperating countries. The report also presents a wide range of solutions for sustainability that have been implemented effectively across EEA partner countries to deliver on the goals of the EGD.

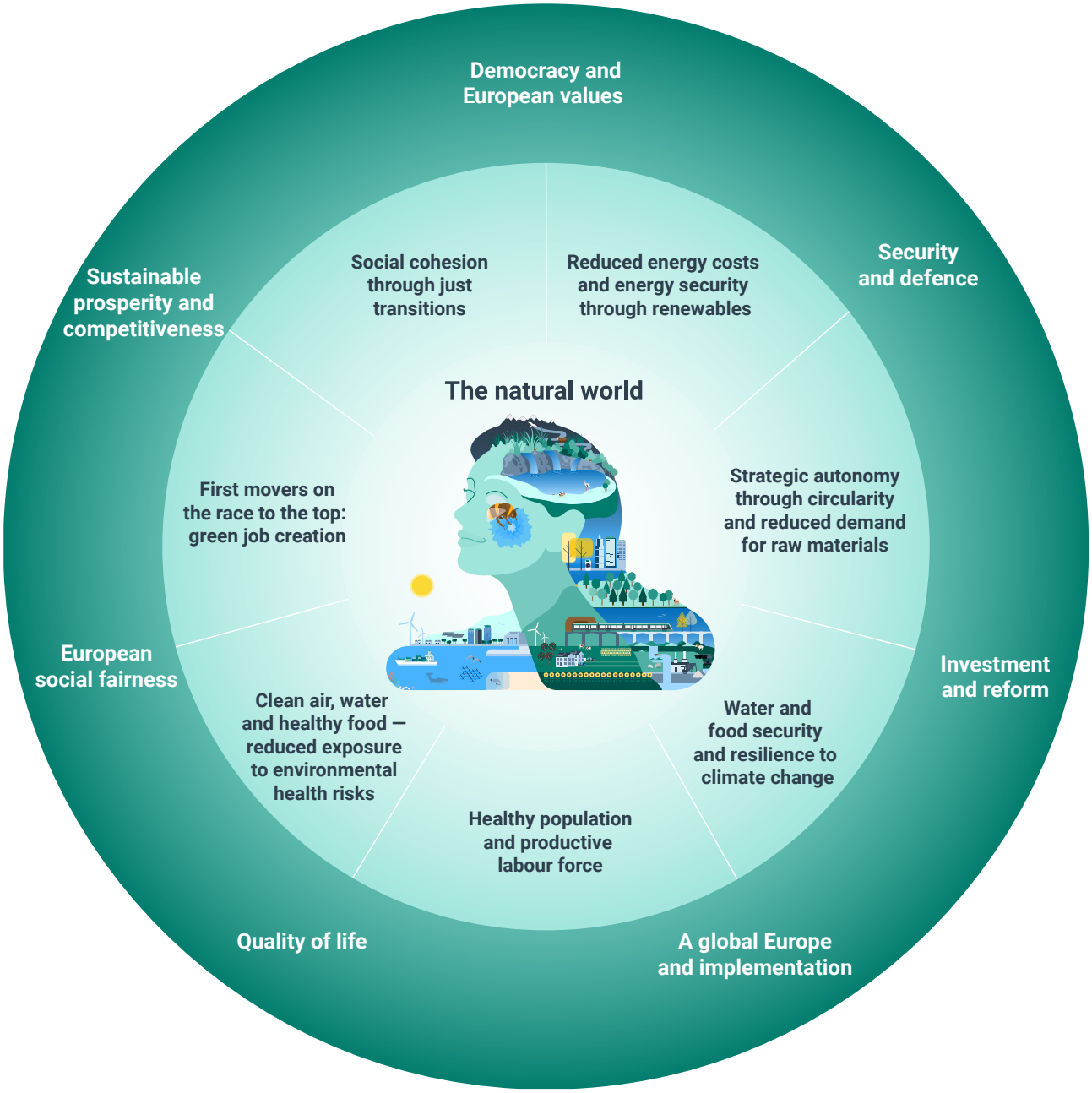
The evidence used in this report has been validated by the European Environment Information and Observation Network — Eionet — a well-known and trusted provider of high-quality data, information and sustainability assessments for Europe. It represents the most reliable, robust and up-to-date evidence currently available on Europe's environment and climate.

1.2 Protecting the environment to ensure sustainable prosperity, competitiveness, security and quality of life

Humans are part of nature and profoundly interconnected with — and dependent on — other species. The natural world underpins our quality of life, our prosperity, and our security. Our diverse terrestrial and aquatic ecosystems ensure water and food security. They regulate our climate and support resilience to climate change. Securing high-quality living standards for generations to come depends on how we manage our natural wealth today.

The 8th Environment Action Programme (8th EAP) — the overarching framework legally agreed upon in the EU for action on environmental policy up to 2030 — includes a long-term priority objective for 2050 of living well within planetary boundaries. High environmental standards foster the ecological resilience needed to underpin sustainable prosperity, security and quality of life for European citizens (Figure 1.1). By continuing to invest in the ongoing transition towards a decarbonised and circular economy, the EU can maintain momentum as a competitive player in the long-term race towards sustainability.

Figure 1.1 **How the sustainability agenda delivers on the key priorities of the European Commission for the 2024-2029 period**



Source: EEA, 2025.

Sustainable prosperity and competitiveness

With its Competitiveness Compass, the EC has renewed its focus on sustainable prosperity and competitiveness as a driver of economic growth. Europe's economy is grounded in natural resources. Recent analysis from the European Central Bank (ECB) demonstrates that the EU's real economy (the part of the economy producing goods and services) and financial system are critically dependent on nature; 72% of euro area companies in the real economy are highly dependent on at least one ecosystem service and 75% of bank loans are granted to companies which are dependent on natural resources(6). Eurostat estimates that 10 ecosystem services – benefits that human derive from nature – generated a total annual flow of benefits worth EUR 234 billion in 2019 in the EU-28, comparable to the gross value added of agriculture and forestry combined(7). The 10 ecosystem services are crop provision, timber provision, pollination, carbon sequestration, flood control, water purification, nature recreation, air filtration and marine fish capture. Thus, delivering competitiveness that is sustainable over the long-term depends on the responsible stewardship of natural resources in Europe.

The Clean Industrial Deal aims to drive growth by decarbonising industry — including greening hard-to-abate sectors — while building leading markets for the development, production and diffusion of clean technology. Circularity will play a key role in bolstering strategic autonomy, ensuring that resources circulate for longer in our economy and reducing import dependencies. Competitiveness is also dependent on social resilience, with a skilled and healthy workforce able to respond to the labour demands of the green and digital transitions.

As such, delivering sustainable prosperity for Europe requires a broad understanding of competitiveness — one that delivers social fairness at the same time as high environmental standards. This requires strategic investments crucial for competitive economic development as well as social and ecological resilience over the long term(8).

Information technology (IT), especially digitalisation, quantum computing and artificial intelligence (AI), offer significant potential to accelerate sustainability across all the core systems. For example, in electricity grids, digital technologies integrate variable energy flows from renewables and improve reliability. Digitalisation may also support the transition to a more circular economy by enabling the implementation of circular business models in the private sector, with digital passports providing an auditable record of a product's lifecycle(9).

In the context of adapting to climate change, digital technologies also inform responses to extreme weather — via early warning systems alerting populations to storms and apps informing farmers about drought-resistant crop species(10). Satellite observations from space and related Copernicus data products serve as a cornerstone for environmental monitoring and enforcement, increasing spatial reach, data granularity and efficiency.

However, digital technologies also have a large and growing environmental impact themselves, requiring increasing quantities of critical raw materials, energy, freshwater and land, while generating electronic and other waste.

Security and defence

Russia's invasion of Ukraine and the need for Europe to shoulder more of the responsibility for its own security has catalysed a paradigm shift in Europe's defence policy(11). The White Paper for European Defence Readiness 2030 aims to close critical capability gaps and build a strong defence industrial base, while

the ReArm Europe Plan/Readiness 2030 provides financial options to unlock up to EUR 800 billion in defence investments over the coming years.

The current geopolitical tensions and threats are also converging with economic, social, environmental and climate crises to create systemic risks to the European way of life. This report argues for a broad understanding of security that encompasses not only military and defence aspects but also ecological and societal resilience. The interdependence of security and resilience, especially when it comes to climate-induced risks, underscores the need for a comprehensive approach[8]. The growth in renewables in Europe, which accounted for 24.5% of the EU's final energy use in 2023 is a win-win for sustainability and security, substantially reducing dependence on Russian fossil gas while also cutting emissions from the energy sectors[12].

Niinistö's report *Safer together: Strengthening Europe's civilian and military preparedness and readiness*[12] identifies climate change and environmental degradation as direct threats to European security. The report highlights the need to build resilience in nature-dependent sectors such as food, water, energy and transport. It cautions against any delay in reducing Europe's carbon footprint. More broadly, it identifies climate change and environmental degradation as threats to international peace, stability and security due to natural resource shortages, extreme weather, increasing migration, and social unrest. People in Europe share these concerns, with 85% of Europeans identifying climate change as a major problem and strong public backing for EU climate policy[13].

The European Preparedness Union Strategy also recognises the interplay between natural disasters, extreme weather events, human-induced disasters, hybrid threats and geopolitical crises. It highlights Europe's dependence on natural resources for food, water and economic security. It emphasises the important role that ecosystems play in climate change mitigation and adaptation, as well as in ensuring food and water security.

Natural ecosystems and nature-based solutions can control erosion, prevent droughts, floods and heatwaves, sequester carbon, promote cooling and prevent wildfires, while simultaneously providing benefits to human well-being and biodiversity[14]. Additionally, biodiversity provides solutions for adapting to changes in the climatic conditions for crop production in Europe in the form of drought-resilient species.

Building on the EEA's European Climate Risk Assessment[15], in 2026 the EC will present a European climate adaptation plan to support Member States in preparing for climate risks and building resilience to climate change.

The 2025 Water Resilience Strategy recognises water as both a basic need and a critical resource — essential to our food, industrial and energy systems. It identifies water resilience as key to the EU's security and crisis preparedness, as well as a significant business opportunity for EU industry in a context where Europe is a global leader in water technology.

European social fairness

A sense of fairness helps build the societal resilience needed to navigate uncertain times. While inequality between Member States has been decreasing, inequalities within countries are on the rise[16]. The transition to sustainability is disproportionately impacting certain social groups and European regions. These include individuals at risk of energy and transport poverty, regions reliant on fossil-fuel-based industries, the farming community adjusting to more sustainable

agricultural practices and young people who will experience profound impacts from the climate crisis. In this context, there is a need to identify, manage and, in some cases, compensate impacted social groups. At the same time, Europe must avoid exacerbating existing inequalities or even creating new ones[17]. Policies and initiatives, such as the Just Transition Mechanism and the Social Climate Fund, have been put in place to support the regions and populations most vulnerable to the negative impacts of sustainability transitions.

The latest strategy documents anticipate that decarbonisation and circularity will contribute to EU employment. Indeed, employment in the renewable energy sector has seen rapid growth, with 2.05 million jobs in the sector globally in 2023, of which 1.81 million were in the EU[18]. At the same time, skill shortages and gaps hamper Europe's competitiveness in this area, with green skills key to a successful green transition. The Union of Skills aims to ensure that everyone in Europe is able to build a solid foundation of skills, with a focus on science, technology, engineering, and maths, and engage in lifelong upskilling and reskilling, in line with the European Pillar of Social Rights.

Social groups also differ in their capacities to embrace clean technologies. Despite being more likely to live in less energy-efficient homes, low-income households struggle to access financial support to retrofit housing and are more likely to face high energy bills and experience energy poverty[19]. The Social Climate Fund aims to assist the most affected groups, for example by supporting energy efficient home renovations and by helping alleviate the social and economic impacts of the new emissions trading scheme (ETS2).

Quality of life

At the most basic level, quality of life depends on secure access to clean air, water and healthy food. Natural environments also provide space for recreation, relaxation and social interaction, and support the functioning of our immune systems. Spending time in nature is proven to improve mental health and cognitive function, reduce deaths from heart disease, reduce incidence of diabetes, and improve overall health[20]. People in Europe are aware of how a clean environment supports their well-being — more than three-quarters of Europeans agree that environmental issues have a direct effect on their daily lives and their health, with four in five considering EU environmental legislation as necessary to protect the environment in their country[73].

The European Water Resilience Strategy identifies water as the driving force of life, with access to clean and affordable water being both a human right and a public good. While most Europeans benefit from access to safe drinking water and sanitation, 1.5% live without basic sanitation and 4% lack access to safe drinking water. The Strategy aims to secure clean and affordable water and sanitation for all, and to engage the public in building water resilience, with sound national water pricing based on the polluter pays principle identified as a useful tool. It calls for effective implementation of the existing policy framework for freshwater to restore and protect the water cycle as the basis for a sustainable water supply, as well as efforts to improve water retention on land. Regarding our use of water as a critical resource, the Strategy aims to enhance water efficiency by at least 10% by 2030 and highlights the potential to limit water needs from the clean industrial and digital transformation and improve water resilience in agriculture.

Across Europe, socially deprived communities are exposed to a higher pollution burden. In many European countries and particularly in cities, low-income groups are disproportionally exposed to air pollution, noise and high temperatures [74].

Addressing the unequal distribution of environmental risks across European society is an important dimension of social fairness.

The polluter pays principle underpins EU environmental legislation and directly addresses fairness, aiming to incentivise polluters to avoid environmental harm. It requires polluters to bear the cost of measures taken to prevent, control and remedy pollution, including its social costs. As an example, revised EU rules for urban wastewater treatment require Member States to apply an additional treatment to remove micropollutants, known as quaternary treatment, by 2045. Under an extended producer responsibility scheme, producers of pharmaceuticals and cosmetics will need to cover a minimum of 80% of the additional costs of this treatment[21].

Democracy and European values

Europe's future depends on a strong democracy, the rule of law and respect of fundamental rights and freedoms. The EC has committed to actively encouraging civic participation in policymaking and transparent engagement with civil society organisations. Participatory approaches can reveal different perspectives and enable public discourse around trade-offs. For example, the vision for agriculture and food emerged from engagement with farmers, food-chain operators, and civil society at the local and regional levels; it aims to build an attractive, competitive, resilient, future-oriented and fair agri-food system for current and future generations.

Young people have been calling for intergenerational fairness in relation to the climate crisis. In this context, the EC has established youth policy dialogues to give young people influence over choices for Europe's future and to encourage their active engagement in democracy.

A global Europe

The EU is a global leader on sustainability and is already widely recognised as a green frontrunner. It has established some of the world's most ambitious environmental goals and legislative frameworks, aiming to be climate-neutral by 2050 under the European Climate Law. Domestic ambition translates into global leadership, with the EU having played a key role in shaping the ambition in international sustainability agreements, including the Paris Agreement, the Kunming-Montreal Global Biodiversity Framework and the ongoing negotiations to develop a global agreement on plastics pollution.

While the financial resources needed to achieve global goals under the Global Biodiversity Framework and the Paris Agreement remain unmet, the EU is a significant contributor as the world's largest provider of official development assistance, accounting for 42% globally in 2022 and 2023[22]. The EU's robust environmental and climate regulations frequently serve as international benchmarks, thereby shaping practices and policies on a global scale.

Nonetheless, as discussed in this report, Europe faces considerable challenges to meet its environmental goals and serve as a truly sustainable role model. By staying on track towards sustainability, the EU will maintain its position as a first mover with a competitive, green and circular economy that delivers prosperity, security and quality of life for the long-term benefit of its citizens.

1.3 Unprecedented pressures on Earth's life support systems

Europe's potential to deliver sustainable prosperity is inherently linked to the global context, as captured by the 8th EAP ambition to 'live well within the limits of the planet'. That context is currently characterised by poly crises, with environmental degradation and climate change placing unprecedented pressures on the life support systems upon which humanity depends. Scientific evidence demonstrates how human activities have transgressed boundaries for six out of nine planetary processes that support life on Earth (Box 1.1). It is therefore not surprising that the World Economic Forum ranks 'critical change to Earth systems' as the third highest global risk in the coming decade in its Global Risks Report 2025. Moving beyond Earth system tipping points could accelerate sea level rise, disrupt major ecosystem services, increase greenhouse gas (GHG) emissions, compromise food security and cause social disruption, representing a significant threat to Europe's security[26].

Box 1.1

Transgressing planetary boundaries

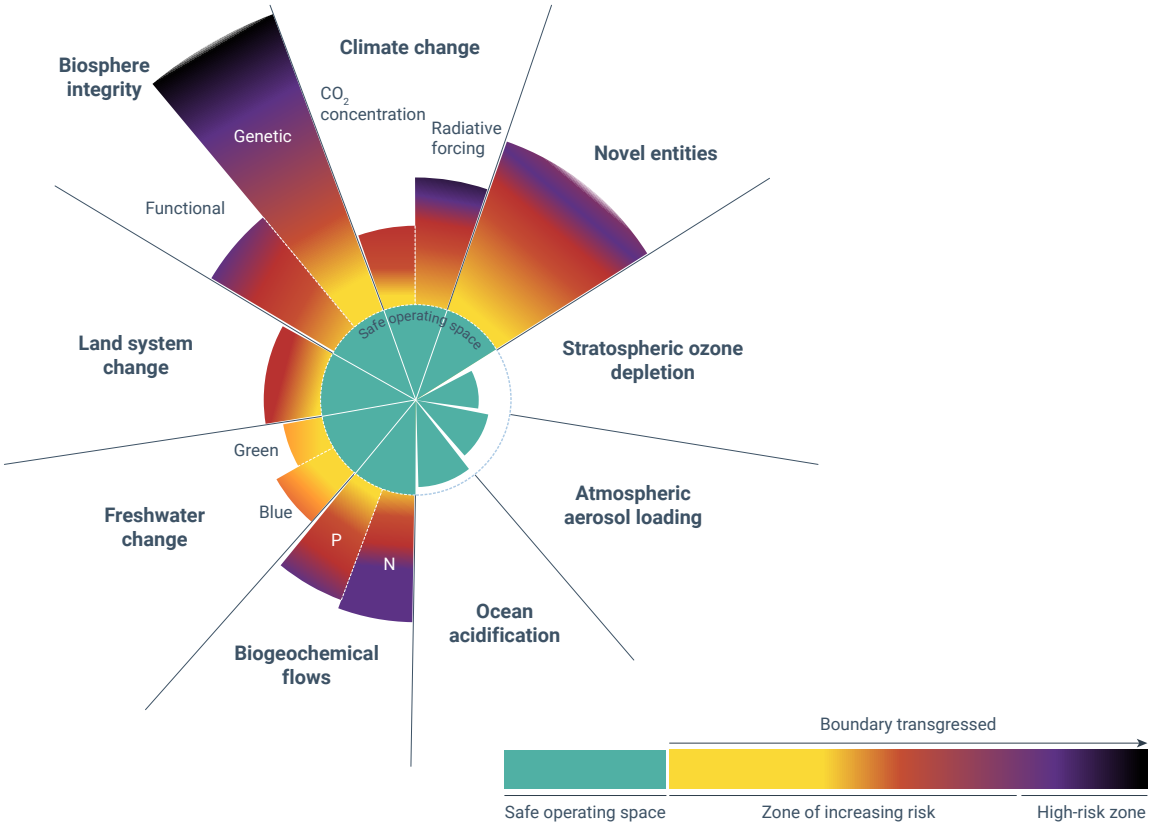
The concept of planetary boundaries identifies nine planetary processes that are critical for maintaining the stability and resilience of the Earth's system — 'planetary life support systems'[23,24,25]. The concept proposes precautionary, quantitative planetary boundaries within which humanity can continue to develop and thrive, also referred to as 'safe operating spaces'. It suggests that once these boundaries are overstepped, humanity increases the risks of large-scale, potentially irreversible damage to Earth systems, thereby jeopardising human life-support mechanisms. While drastic change may not occur immediately, the thresholds represent tipping points past which a small change in conditions can lead to large, abrupt changes in the function and structure of a system, shifting it from one state to another and endangering the core processes sustaining life.

The latest update on the status of the nine boundaries, presented in Figure 1.2 below, concludes that six planetary boundaries have been transgressed:

- climate change (the change in the ratio of incoming and outgoing energy of the Earth);
- novel entities (synthetic chemicals and substances such as microplastics);
- modification of biogeochemical flows (industrial and agricultural processes disrupt natural cycles of nitrogen and phosphorus);
- freshwater change (alteration of freshwater cycles, including rivers and soil moisture);
- land system change (the transformation of natural landscapes, such as through deforestation and urbanization); and
- biosphere integrity (the diversity, extent, and health of living organisms and ecosystems).

Limits for ocean acidification (the acidity of ocean water increases as it absorbs atmospheric carbon dioxide (CO_2)) and atmospheric aerosol loading (levels of airborne particles from human activities and natural sources) are under pressure. Levels of stratospheric ozone depletion are well within limits, making this the only boundary not threatened or crossed. This assessment suggests that humanity is already operating far beyond safe limits[24].

Figure 1.2 Exceedance of six planetary boundaries



Note: Radiative forcing is the perturbation to the energy balance of the earth-atmosphere system following, for example, a change in the concentration of carbon dioxide or a change in the output of the sun.

Source: Richardson et al.[24].

The triple crisis of climate change, biodiversity loss and pollution

Recent global assessments from the Intergovernmental Panel on Climate Change, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, the International Resource Panel and the United Nations Environment Programme present robust scientific evidence of how the scale of the climate and environmental crisis threatens human lives and livelihoods, economies, and the planet's life-support systems.

Science calls for urgent and fundamental change to address these challenges. Despite the clarity of the scientific evidence, the global policy response remains inadequate, with each further year of delay shortening the time available to transform our production and consumption systems towards sustainability.

Climate change, biodiversity loss and pollution are deeply interconnected. For example, climate change is a direct driver of biodiversity loss and further compounds other drivers, amplifying biodiversity decline[27]. Floods that destabilise landfills and industrial infrastructure spread pollution and plastic waste. Droughts increase windblown dust and wildfires generate smoke. Deforestation results in biodiversity loss, while also releasing GHGs that accelerate climate change.

Conversely, biodiversity and healthy ecosystems play a vital role in mitigating and adapting to climate change. Consequently, integrated solutions to tackling climate change, biodiversity loss and pollution can provide multiple benefits[29].

Climate change

Climate change is accelerating rapidly driven by emissions of greenhouse gases from human activities. Global GHG emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production[30]. In 2024, humanity experienced unprecedented average temperatures globally, building on the record-breaking heat in 2023. For the first time, the annual average temperature clearly exceeded 1.5 degrees centigrade (°C) above pre-industrial levels — breaking through the threshold set by the Paris Agreement. This represents average temperature levels never previously experienced by humanity during the Holocene epoch —the period in which human civilisation emerged and flourished[31].

Vulnerable communities that have historically contributed the least to climate change are disproportionately affected[30]. Around the world, people face exposure to extreme weather events that threaten their well-being, health and survival[32]. In 2024, many extreme weather events — including flooding, extreme heat, drought and wildfires — occurred[31], claiming lives and disrupting livelihoods worldwide.

Extreme heat is driving mortality and morbidity; in other words, death and disease. Droughts are causing dust storms, sand storms and wildfires, resulting in dangerous levels of air pollution. Floods contaminate water and put people and animals at risk of drowning. The distribution patterns of infectious diseases, such as dengue and malaria, are shifting with changing precipitation patterns and rising temperatures. These impacts are most acutely felt in low- and middle-income countries where they combine with poverty and weak healthcare infrastructure, as well as low levels of insurance[32].

In response, deep, rapid and sustained mitigation, alongside accelerated adaptation, are needed this decade. Based on current nationally determined contributions (NDCs) – national climate action plans set by countries under the Paris Agreement – the world is on course for a global temperature increase of 2.6°C to 2.8°C this century. However, current policies are insufficient to deliver these NDCs, rather they are estimated to limit global warming to 3.1°C. Countries must collectively cut 42% off GHG emissions by 2030 to limit the temperature increase to 1.5°C, with cuts of 57% needed by 2035. This will require global mobilization to reverse the trend. Since 1990, global GHG emissions have risen by more than 60%, with a new record of 57.1 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) emitted in 2023. To put this in context, in 2024, the remaining carbon budget was estimated at 900 $GtCO_2$ for limiting warming to below 2°C, and at 200 $GtCO_2$ to stay below a 1.5°C limit[33].

Ongoing increases in GHG emissions at the global level will exacerbate global warming. At the same time, losses and damages will continue to escalate. Furthermore, both human and natural systems will reach the limits of their capacity to adapt to risks. The likelihood and impacts of abrupt and/or irreversible changes in the climate system — including changes triggered when tipping points are reached — increase with further global warming. Key tipping points include:

- the collapse of the West Antarctic and Greenland ice sheets;
- the melting of the Arctic permafrost;

- the collapse of the Atlantic meridional overturning circulation (a system of ocean currents in the Atlantic Ocean that bring warm water north and cold water south); and

- the dieback of the Amazon Forest[34].

Nevertheless, there are seeds of change. The energy crisis triggered by Russia's invasion of Ukraine has accelerated the transformation of European energy markets, with the roll-out of clean energy bolstered by both the urgent need for energy security and the availability of affordable clean technologies. Deployment of renewables has been shown to improve energy security, delivering locally-produced renewable energy, better efficiency and reduced exposure to energy price fluctuations[35]. In 2023, global renewable power capacity rose by an estimated 36% compared to 2022[36], while the number of jobs in the renewables sector increased from 13.7 million in 2022 to 16.2 million, reflecting a year-on-year increase of 18%[37]. At the same time, however, markets for clean technologies have become more fragmented at the global level; for example, since 2020, almost 200 trade measures affecting clean energy technologies — most of them restrictive — have been introduced around the world[35].

In the context of the energy crisis, some countries have reverted to fossil fuels to secure their energy supply. As a result, fossil fuel subsidies have nearly doubled at global level and are now at a record high[38]. Conflict in the Middle East and Russia's ongoing war in Ukraine show that risks to energy security are an ongoing trend at global level.

Biodiversity loss

Up to 1 million species face extinction unless action is taken to stop biodiversity loss. The rate of decline is tens to hundreds of times higher than the average over the past 10 million years. An estimated 75% of the Earth's land surface and 66% of the marine environment have been significantly altered by human activities[39].

Forests, wetlands and grasslands are under threat. Deforestation is driven by agriculture, logging and infrastructure development. Meanwhile, desertification results from overgrazing, deforestation and unsustainable farming practices, accelerated by climate change. Land degradation has reduced agricultural productivity in 23% of the global terrestrial area, while global crop output is at risk due to pollinator loss, driving food insecurity[39].

In the marine environment, coral reefs, seagrasses and mangroves are disappearing due to pollution, overfishing and climate change, with 50% of coral reefs lost or severely degraded at global level[8]. If the current trends continue, climate change will lead to the irreversible loss of marine biodiversity, such as coral reefs, alongside negative effects for coastal fisheries[40].

Habitat destruction disrupts natural interactions and increases contact between wildlife, livestock, people and their respective pathogens, leading to the emergence of zoonotic diseases[41]. COVID-19 was the latest example of a pandemic caused by the spillover of a pathogen from an animal to the human population, with previous outbreaks including Severe Acute Respiratory Syndrome, Middle East Respiratory Syndrome, zoonotic influenza, mpox and Ebola virus[42]. COVID-19 resulted in over 7 million deaths worldwide and led to a global recession, with the stock markets experiencing their worst crash since 1987[43].

Pollution

Pollution — including air pollution, noise, chemicals, waste and plastic — poses significant threats to human health, ecosystems and biodiversity across the world. Pollution is the number one environmental cause of disease and premature death in the world today, with diseases driven by pollution behind an estimated 9 million premature deaths in 2015 — 16% of all deaths worldwide. This represents three times more deaths than from acquired immunodeficiency syndrome (AIDS), tuberculosis and malaria combined[44].

Outdoor air pollution caused 4.2 million premature deaths worldwide in 2019, with this mortality driven by exposure to fine particulate matter, which causes cancers and cardiovascular and respiratory disease. The vast majority — 89% — of those deaths occurred in low- and middle-income countries, while 99% of the world's population lives in places where the air quality does not meet World Health Organization (WHO) guidelines[45].

Resource consumption

The volume of material used by people at global level has increased more than three times over the last 50 years and continues to grow by 2.3% annually. Globally, the built environment and mobility systems are the principal source of demand, followed by food and energy systems. Together these account for about 90% of worldwide material consumption[46]. Globally, the extraction and processing of material resources — i.e. the entire industrial chain needed to bring resources to market — account for over 55% of GHG emissions and 40% of health impacts due to air pollution caused by particulate matter. Meanwhile, growing and harvesting biomass (agricultural crops and forestry) contribute over 90% of total global land use-related biodiversity loss and water stress[46]. Additionally, the increase in clean energy technologies has intensified international competition for critical minerals and resources essential to the green transition.

The use of material resources is deeply unequal. Per capita, high-income countries consume six times more materials and drive 10 times more climate impacts than low-income countries. High-income countries displace the environmental impacts of their consumption to other regions through trade. Addressing this inequity is core to global efforts to deliver sustainability.

Reducing resource use is key to achieving sustainability, both at the global and European levels. Production-side measures to increase resource efficiency and foster circularity must be complemented by measures to reduce demand and promote sufficiency[46].

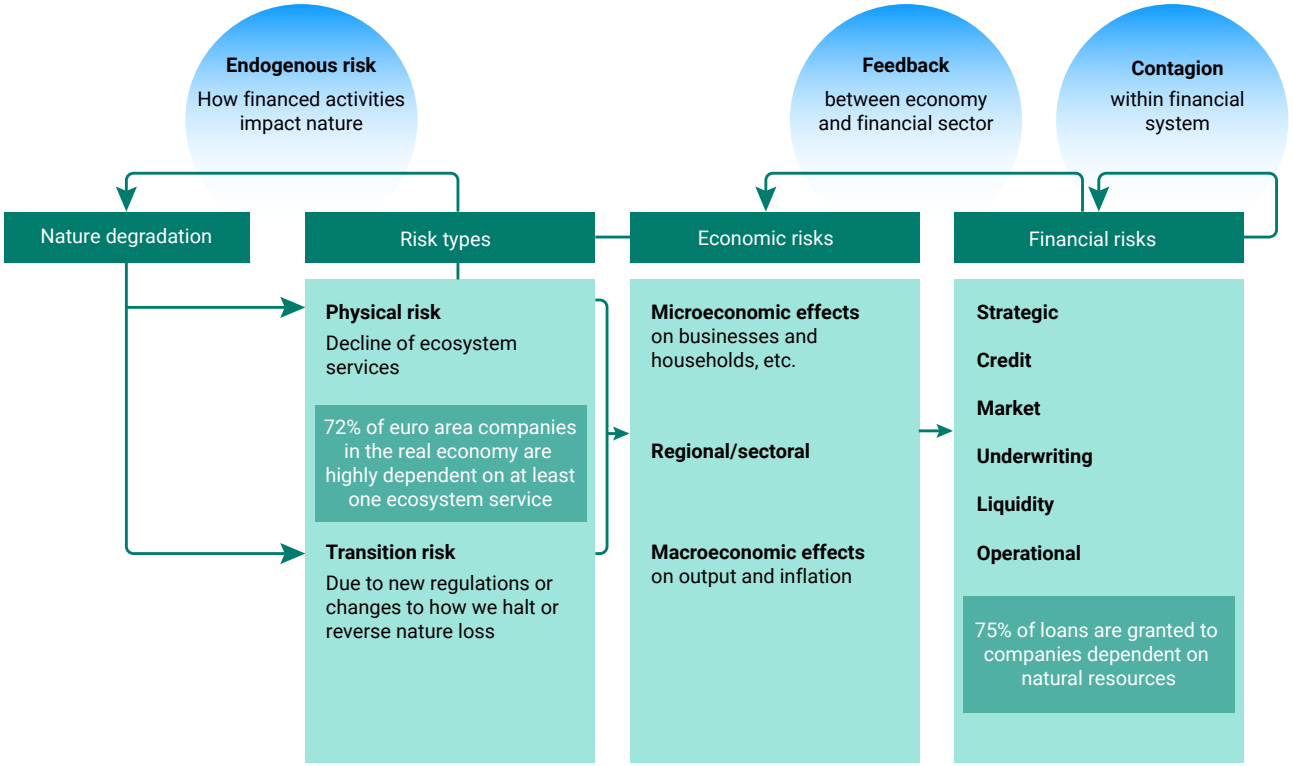
1.4 Economic costs of climate change, biodiversity loss and pollution

Environmental degradation and climate change threaten the global economy, with over half the market value of listed companies subject to nature-related risks. An estimated 55% of global gross domestic product (GDP) is moderately or highly dependent on ecosystem services[47]. This economic value is at risk from ecological degradation and climate change, which affect prices and lead to financial stability through diverse channels (Figure 1.3). These risks include physical damage to infrastructure and activities; for example, the loss of a single bee species may reduce yields in fruit production, or flooding linked to climate change may damage industrial infrastructure. They also include transition risks that arise from the need for companies to adapt to changes to the regulatory landscape, consumer preferences

and investor expectations. For example, a company that fails to adapt to the regulatory landscape may be at risk of litigation, including liability claims, fines and claims of misconduct.

The economic impacts of climate change and environmental degradation on companies producing goods and services can translate into risk for financial systems, including credit risks, market risks and underwriting risks. Such risks can then amplify in the financial system by the compounding of individual risks – whereby multiple risks interplay to increase overall impact – or through financial contagion[48]. Climate change presents a systemic risk to the European macro-fiscal and financial system and the real economy, with effects transcending both borders and sectors. There is a high potential for private financial risks to be transferred to the public sector, amplifying the impacts of climate change on public finance[49].

Figure 1.3 **Transmission pathways for physical climate- and nature-related risks for public finance**



Source: EEA[14].

Economic costs of climate change

From 2000 to 2019, the global costs of extreme weather attributed to climate change are estimated to be EUR 2.34 trillion globally: an average of EUR 117 billion per year. This estimate is based on the economic damage and human losses driven by 185 extreme weather events linked to climate change, in which over 160,000 human lives were lost(50).

Looking forward, the expectation is that climate change will continue to cause major economic damage over the next 25 years, particularly to agriculture, health, infrastructure, finance and labour productivity. The World Economic Forum ranks extreme weather events as the second-highest risk to the global economy in the next 2 years and the highest risk in the coming decade(26).

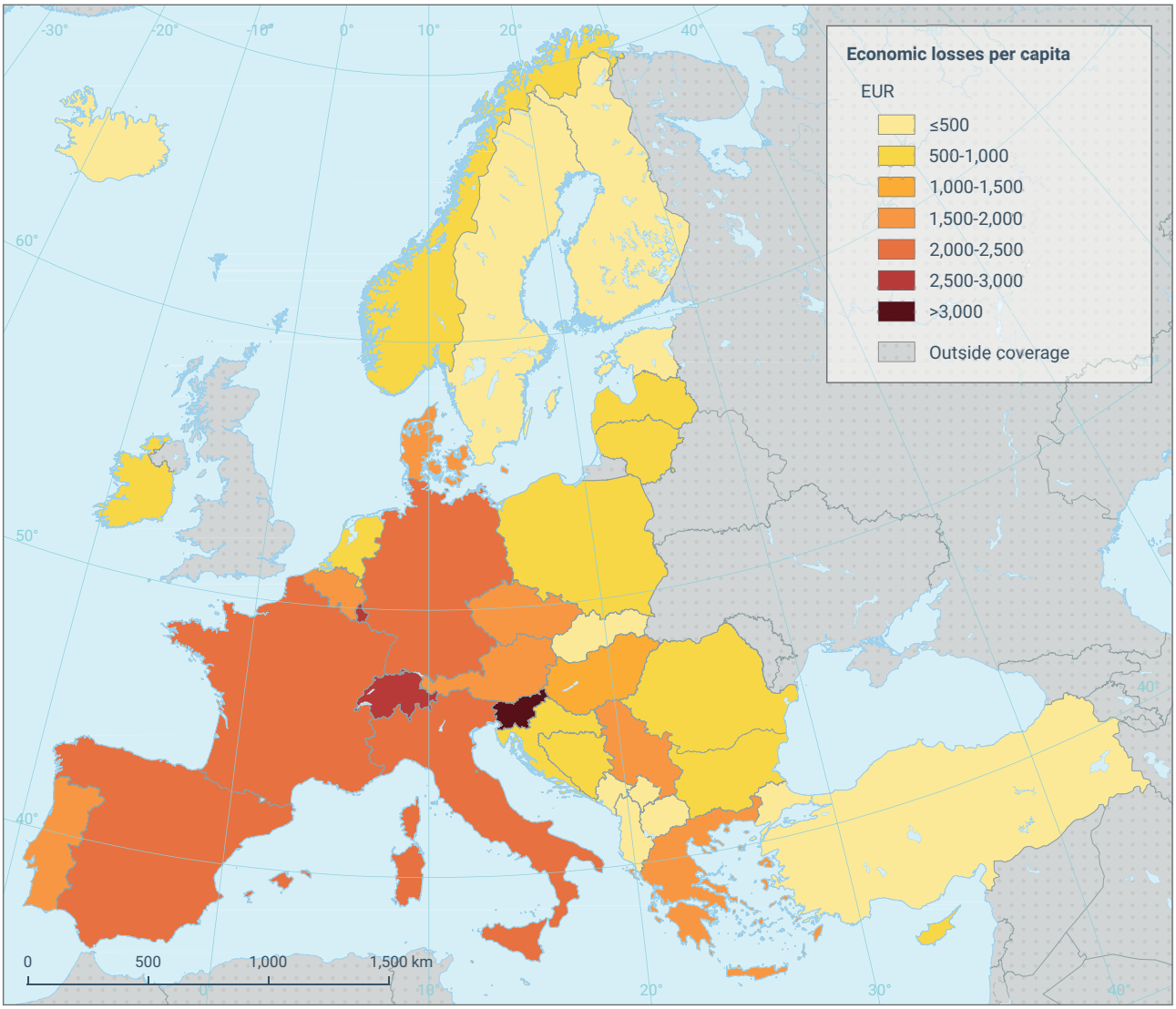
One recent study estimates that the world economy will have experienced an income reduction of 19% by 2049, relative to a baseline without climate impacts. Global annual damages resulting from rising temperatures, changes in rainfall, and temperature variability are estimated to be EUR 28 trillion. Accounting for extreme weather, such as storms or wildfires, would further raise increase damage estimates. Significantly, damages up to 2049 will result from past GHG emissions and are unavoidable, meaning they will play out regardless of mitigation efforts. However, post-2049 damage estimates diverge strongly across emission scenarios, underlining the clear imperative for mitigation efforts today(51).

Another recent estimation looked at the impact of climate change-induced transition and physical damages on global equity valuations; it found them to be as large as 40% if abatement remains at historic rates, even if climate tipping points are not triggered. An abatement policy aimed at limiting warming to 2°C could limit downward equity revaluation to 5-10%(52).

Within the EU the costs of climate change have become starkly apparent in recent years. A growing share of Europe's population are directly impacted; in 2025 38% of Europeans report feeling personally exposed to climate-related risks(13). Weather- and climate-related extreme events have resulted in over 240,000 fatalities from 1980 to 2023 in the EU-27. Over the same period, the EU-27 experienced approximately EUR 738 billion in economic losses due to weather- and climate-related extremes(53). Map 1.1 shows the total economic losses per capita over from 1980 to 2023. Slovenia has the highest losses per capita, amounting to EUR 8,733 between 1980 and 2023. This is followed by Luxembourg (EUR 2,694), Switzerland (EUR 2,685), Italy (EUR 2,330) and Spain (EUR 2,279)(54).

In this context, the insurance industry faces growing costs, tightened reinsurance capacities and escalating premiums. Most EU countries have insurance gaps of over 50%, with many homes uninsured against extreme weather events(54). Governments must then shoulder the costs of post-disaster relief, which results in delays in rebuilding, and leads to business closures and property abandonment(55).

Map 1.1 **Total economic losses from weather- and climate-related events per capita from 1980 to 2023**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Note: This map displays the economic losses per capita in each country. Data were aggregated for 1980-2023 and all weather- and climate-related event types.

Source: EEA[54].

Extreme weather events present a key challenge for Europe's agricultural sector and hence long-term food security in the EU. In 2022, severe drought in much of Europe led to considerable yield losses of up to 60% for maize, with over 313,000km² of cropland affected by drought – an area almost the size of Poland[56]. In 2023, hot, dry conditions in Spain reduced summer yields and drove up the prices of Spanish tomatoes, broccoli and oranges by 25-35% affecting affordability for consumers[57]. Meanwhile, in 2023 and 2024, olive oil prices reached unprecedented highs after droughts and high temperatures severely impacted the Spanish harvest[58].

Looking at recent trends for key crops, it is estimated that in 2024 and 2025, EU cereal production will be around 7% below the 5-year average and the lowest in a decade. This is attributed to unfavourable weather conditions affecting yields and, in part, a decrease in cultivated area because of excessive rain disrupting planting. EU oilseed production in 2024/25 is expected to fall by 8% in comparison to 2023/24; this is due to a reduction in the area of rapeseed cultivated and adverse weather conditions affecting sunflower cultivation[58]. In 2024, wine production in the EU fell to the lowest level since the start of the 21st century, 11% below the 5-year average; wine industry experts attributed this to climate change[59].

Looking ahead, rising temperatures and extreme weather events are expected to further impact agricultural production in Europe. Drought and high temperatures threaten both rain-fed and irrigated crops, such as wheat, maize, potato, barley and rice, as water stress affects growth and can significantly reduce crop yields. Significant reductions in yields of wheat due to droughts are projected at 2°C of warming, with the highest reductions in percentage terms expected in Spain, Romania, southern Italy and Cyprus[60].

Economic costs of biodiversity loss

In 2023 over half of the world's GDP — approximately EUR 54 trillion — was generated by economic activities dependent on nature. Five sectors (namely: agriculture; forestry; fisheries and aquaculture; food, beverages and tobacco; and construction) are highly dependent on nature, with 100% of their economic value (approximately 12% of global GDP) derived from natural resources[47]. In this context, the World Economic Forum ranks biodiversity loss and ecosystem collapse as the second highest global risk of in the coming decade[26].

A recent estimate of nature-related economic risks found global economic shocks from biodiversity loss and ecosystem damage could cost more than EUR 4.6 trillion. Water-related risks were the most significant, potentially driving costs of up to 7-9% of global GDP through major impacts on the manufacturing and agricultural sectors. Meanwhile, 12% of agricultural output is at risk due to pollinator decline[61]. Global pollination services for crops – whereby pollinator insects such as bees, wasps, beetles, flies, ants and butterflies transfer pollen between plants and stimulate the growth of fruits, vegetables and seeds – are valued at EUR 845 billion[62].

Europe's economy is built on natural resources. In the euro area, 72% of non-financial corporations — around 3 million companies — are critically dependent on ecosystem services. Some 75% of all corporate loans in the euro area are granted to companies that are critically dependent on at least one ecosystem service[6]. The European Insurance and Occupational Pensions Authority found approximately 30% of insurers' investments are critically dependent on ecosystem services[63].

Europe's financial stability depends directly on the resilience of our ecosystems.

Economic costs of pollution

Estimating the economic cost of pollution is challenging given how pervasive pollution is and how it is treated as an externality in our economic and financial systems – a cost caused by economic activities that falls on third parties, in this case the environment. The costs are borne by society in the form of health costs and environmental degradation. The World Bank estimates that the global cost of health damages associated with exposure to the main air pollutant, fine particular matter, was EUR 7.23 trillion in 2019, equivalent to 6.1% of global GDP[64].

In the EU — and despite significant progress in improving air quality — exposure to fine particulate matter, ozone and nitrogen dioxide caused an estimated 239,000, 70,000 and 48,000 premature deaths, respectively in 2022[65]. In addition to premature mortality, the impacts from living with chronic diseases — such as cardiovascular disease, diabetes, lung cancer and asthma – are significant.

A 2024 study[66] based on EEA data estimated that air pollution costs the EU EUR 600 billion each year, equal to 4% of GDP. Costs include productivity losses such as absenteeism due to illness, reduced in-job productivity and damage to water bodies, crops and forests; notably, however, the estimates did not include healthcare costs. These costs are unevenly distributed across the EU and rise to more than 6% of GDP in the more polluted areas of eastern Europe and Italy. The economic benefits of reducing pollution outweigh the costs of air pollution control strategies in the EU[66].

Focusing on the impacts of industrial pollution, from 2012 to 2021 the aggregate external cost of industrial air emissions in the EU is estimated to have totalled up to EUR 4.3 trillion. Notably, the annual costs fell by a third over the decade, demonstrating how policies to mitigate and control pollution have reduced environmental damage and societal costs. Nevertheless, the external costs of industrial air pollution still stood at EUR 353 billion in 2021, equivalent to 2% of EU GDP[67].

A 2021 report estimated the annual costs of water pollution from nitrogen and phosphorus (predominantly from agriculture) in the EU to be over EUR 22 billion per year. Of this, only 3.8% was paid by polluters through taxes, leaving 96.2% of the cost to be borne by society[68] Crucially, a European Court of Auditors' report noted that the polluter pays principle is inconsistently applied across EU environmental policies, leaving the taxpayer to cover much of the cost of pollution[75].

Chemical pollution also generates costs that end up being covered by taxpayers, both through clean-up costs and health impacts. Human exposure to per- and polyfluoroalkyl substances (PFAS) has been estimated to cost EUR 52-84 billion in annual health costs in Europe due to endocrine, immune, reproductive and developmental effects[69].

Moreover, the European Central Bank found that businesses, the financial sector and policymakers have long underestimated the economic significance of ecosystem services. Many of these services, such as soil formation, watersheds and pollination, are public goods that are either undervalued in markets or not priced in at all. As a result, they are overlooked in economic decisions, with significant consequences for the natural world[48]. Given how our health, our economy, and our food and water security depend on these services, this oversight presents a risk to prosperity and security in Europe.

1.5 Transformation of Europe's production and consumption systems

Environmental degradation and climate change present a profound challenge for humanity that threatens to undermine human health, prosperity and the planet's very life-support systems. The scale and urgency of change required to mitigate these risks can be daunting. While it is not too late to act, our window of opportunity is closing quickly. Taking decisive action now is critical to preventing the worst climate impacts[30]. Equally, it remains possible to stop biodiversity loss if we act swiftly and at sufficient scale[70].

There is a need to transform, not just reform, our key production and consumption systems — such as the built environment, industry, mobility, food and energy — as they currently account for a substantial share of global resource use and have significant environmental and climate impacts. Past EEA reports have made repeated calls for fundamental sustainability transitions in the production and consumption systems that shape the European economy and modern social life[71,72].

The systems we have built to meet human needs and demands are the foundation for well-being but they are also driving climate change, biodiversity loss and pollution. Europe already has the knowledge, tools and resources necessary to confront these challenges. The significant progress that has been made to date towards transforming the energy system can serve as a model and must now be accelerated and replicated across the other key systems.

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2 The evolving European policy framework

Key messages

- The Competitiveness Compass is the European Commission's strategic policy framework to 2029. The three areas for action set out in the compass — innovation, decarbonisation and security — all have strong environment and climate dimensions, with clean industry, energy system transformation, circular economy and reducing import dependencies as key priorities.
- The European Green Deal represented a paradigm shift in the move towards sustainability, aiming to drive transformations across systems and sectors, with a long-term vision of living well within the limits of the planet and of becoming climate-neutral by 2050.
- Implementing and delivering on the legislative developments agreed under the European Green Deal remain a priority.
- The EU's ambitious climate targets and high environmental standards have made Europe a credible leader in negotiations on global multinational agreements, such as the Paris Agreement and the Kunming-Montreal Global Biodiversity Framework.

2.1 Looking forward — the Competitiveness Compass

Early in 2025, the European Commission (EC) presented the Competitiveness Compass. It provides a strategic framework to steer the EC's work up to 2029. The compass aspires to make Europe the place where future technologies, services and clean products are invented, manufactured and marketed, while at the same time as becoming the first climate-neutral continent.

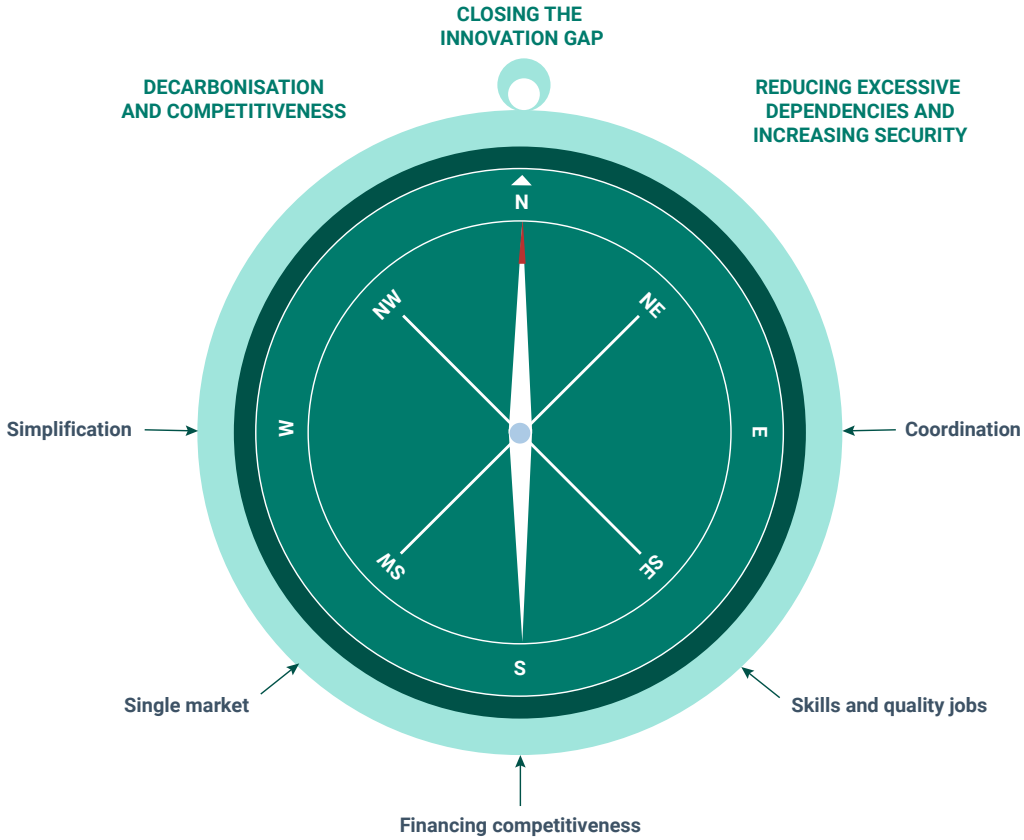
It builds on Draghi's report on the future of European competitiveness[1], which identifies key challenges, including:

- dependence on external suppliers for critical raw materials and digital technology;
- high energy prices;
- a failure to translate innovation into commercialisation;
- a poorly-coordinated industrial policy; and
- regulatory barriers[1].

It also responds to Enrico Letta's report on the future of the Single Market[2], which calls on the EU to leverage the single market to retain relevance in a competitive global economy. The Competitiveness Compass identifies three pillars for action, complemented by five horizontal enablers (see Figure 2.1).

The following section considers the initiatives expected to influence the sustainability agenda, without aiming to provide a comprehensive assessment. Three of the five enabling factors — namely simplification, financing competitiveness, and skills and quality jobs — are considered in Box 2.1, Box 2.2 and Box 2.3, respectively.

Figure 2.1 **The three pillars and the five horizontal enablers of the competitiveness compass**



Source: EC[3].

Box 2.1

Simplification

The Compass sets a target to cut the administrative burden for firms by at least 25% and by at least 35% for small and medium-sized enterprises (SMEs) by 2029. To this end, the EC has proposed simplification measures to reduce regulatory and administrative costs for business. It also aims to make procedures for accessing EU funds simpler while speeding up EU administrative decision-making. Several legislative proposals have been made to deliver on these aims, including:

- Omnibus I and II propose to streamline rules on sustainability reporting, due diligence rules, the Carbon Adjustment Mechanism (CBAM), and EU investments;
- Omnibus III proposes to simplify the Common Agricultural Policy;
- Omnibus IV proposes to simplify rules and reduce bureaucracy across the Single Market; and
- Omnibus VI proposes to simplify certain requirements and procedures for chemical products.

The proposals have been submitted to the European Parliament and the Council for their consideration.

Closing the innovation gap to drive productivity

The first pillar aims to:

- facilitate start-ups and support the scale-up of new companies
- invest in state-of-the-art infrastructure; and
- boost innovation and research.

The Compass aims to make Europe a leader in tech sectors such as Artificial Intelligence (AI), semiconductor and quantum technologies, advanced materials, biotech, clean energy, robotics and space technologies, as well as connected and autonomous mobility.

Box 2.2

Financing competitiveness

The savings and investments union[4] aims to create new savings and investment products, provide incentives for risk capital and channel savings towards productive investments. In particular, the Clean Industrial Deal aims to mobilise over EUR 100 billion to support EU-made clean manufacturing. To achieve this, the EC will:

- adopt a new framework to accelerate the approval of state aid to support the roll-out of renewable energy, decarbonise industry and ensure sufficient clean-tech manufacturing capacity;
- strengthen the Innovation Fund and propose an industrial decarbonisation bank, aiming for EUR 100 billion in funding, based on available funds in the Innovation Fund and additional revenues resulting from parts of the Emissions Trading System (ETS);
- launch a dedicated call under Horizon Europe to stimulate research and innovation in these areas; and
- amend the InvestEU Regulation to increase the number of financial guarantees available to support investments, which will mobilise up to EUR 50 billion for the deployment of clean tech, clean mobility and waste reduction.

Decarbonising our economy

The second pillar aims to drive growth and integrate decarbonisation policies within industrial, competition, economic and trade policies.

Under this pillar, the Clean Industrial Deal[5] aims to drive decarbonisation, competitiveness and circularity. It sets out actions to support the decarbonisation of energy-intensive industries — such as steel, metals and chemicals — and to tackle the high energy costs faced by industry. To this end, the Action Plan for Affordable Energy aims to:

- speed up the roll-out of clean energy;
- accelerate electrification;
- complete the Energy Union through a fully integrated energy market and a cohesive governance framework;
- use energy more efficiently; and
- cut dependence on imported fossil fuels[6].

The Clean Industrial Deal also aims to boost the clean-tech sector by fostering demand, building on the Net-Zero Industry Act[7]. An Industrial Decarbonisation Accelerator Act, foreseen for late 2025, aims to increase sustainable and resilient industrial production in energy-intensive industrial sectors in the EU by supporting decarbonisation investments. The act will speed up permitting procedures for industrial decarbonisation; identify and promote priority industrial decarbonisation projects and clusters; and create and protect European lead markets for European

low-carbon products. Implementation of the act within sectors will be supported by targeted initiatives, including:

- the Industrial Action Plan for the European automotive sector[8];
- the European Steel and Metals Action Plan[9];
- a sustainable transport investment plan (foreseen for the autumn of 2025); and
- a European Chemicals Industry Action Plan, accompanied by a proposal for a simplification omnibus on chemicals and a proposal regarding the European Chemicals Agency (ECHA).

The Deal also aims to make the EU the world leader in circular economy by 2030 to maximise resource use, reduce dependencies and enhance resilience, cut waste and carbon dioxide (CO_2) emissions, lower production costs and enhance competitiveness. The aim is to increase the circular material use rate from 11.8% today to 24% by 2030. It foresees fast implementation of the Critical Raw Materials Act — a mechanism to aggregate demand from across the EU for strategic raw materials — and the establishment of an EU critical raw material centre to jointly purchase raw materials under better terms. In 2026, the EC will adopt a Circular Economy Act aiming to enable the free movement of circular products, secondary raw materials and waste, foster a higher supply of high-quality recycled materials and stimulate demand for secondary materials and circular products while bringing down feedstock costs.

The Framework for state aid measures to support the Clean Industrial Deal helps Member States to support the development of clean energy, industrial decarbonisation and clean technology.

Finally, the Clean Industrial Deal aims to foster social fairness and a just transition, whereby people and communities benefits from quality jobs and businesses attract top talent, supported by the Union of Skills and a Quality Jobs Roadmap foreseen for late 2025 (Box 2.3).

A new Bioeconomy Strategy, due for adoption by the end of 2025, aims to stimulate growth in bio-based materials, biomanufacturing, biochemicals and agri-biotech sectors, reduce reliance on fossil fuels and improve economic prospects in rural areas. The strategy will also focus on reinforcing circularity and sustainability while contributing to the decarbonisation of the EU economy[10].

Box 2.3

Skills and quality jobs

Labour market participation is impacted by the changing demand for skills, Europe's ageing population and the phase-out of carbon-intensive sectors as the green-tech sector expands. The EU's workforce must have the necessary skills to support the transition to a low-carbon economy, including skills in clean technologies, digitalisation and entrepreneurship. The Union of Skills aims to:

- improve basic and advanced skills;
- provide opportunities for people to regularly update and learn new skills;
- facilitate recruitment by businesses across the EU; and
- attract, develop and retain top talent in Europe.

It also aims to help the free movement of workers to support the circulation of skills across the EU[11]. A Quality Jobs Roadmap is foreseen for the end of 2025, and aims to:

- support fair wages and working conditions;
- ensure high health and safety standards; and
- provide training and fair job transitions for all.

Reducing excessive dependencies and increasing security

The third pillar aims to integrate security and strategic autonomy more tightly into EU economic policies. Clean trade and investment partnerships are foreseen to secure the supply of raw materials, clean energy, sustainable transport fuels and clean tech from across the world. The review of public procurement rules will support European providers in critical sectors and technologies, boosting demand for goods produced to Europe's high standards.

Strategies and initiatives under the Competitiveness Compass

Since the launch of the Competitiveness Compass in January 2025, the EC has launched several initiatives and legislative proposals. Those most relevant to environment, climate and sustainability are briefly introduced below.

On climate, the EC proposed an amendment to the EU Climate Law, setting a 2040 EU climate target of 90% reduction in net greenhouse gas (GHG) emissions, compared to 1990 levels, in line with the scientific advice of the European Scientific Advisory Board on Climate Change[12]. The Commission proposal also introduces flexibilities to consider in designing the future legislative instruments to achieve this 2040 climate target. These include a limited role for high-quality international credits starting from 2036, the use of domestic permanent removals in the EU Emissions Trading System (EU ETS), and greater flexibilities across sectors to help achieve targets in a cost-effective and socially fair way. The EC will present a European Climate Resilience and Risk Management initiative in the second half of 2026.

The Preparedness Union Strategy aims to boost the EU's ability to anticipate, prevent and respond to a range of threats and crises, from geopolitical tensions and conflicts, cybersecurity and information manipulation risks, to climate change and increasing

risks of natural hazards. The latter include floods, wildfires, earthquakes and extreme weather events exacerbated by climate change.

The Strategy acknowledges how the changing climate and extreme weather events increasingly threaten European economic security and calls for improved resilience and preparedness at both the EU and Member State levels. It also calls for regular updates to climate risk assessments and design improvements to critical infrastructure. Integrating climate resilience into urban planning, deploying nature-based solutions, developing nature credits and implementing adaptation actions in agriculture while preserving food security, are presented as means to protect the EU economy and society from natural calamities.

Foresight and anticipation are identified by the Preparedness Union Strategy as key concepts to develop a comprehensive assessment of risks and threats in the EU. The strategy aims to ensure the resilience of vital societal functions, such as food security, drinking water, energy supply, waste management, the protection of nature and flood resilience. It identifies key elements needed to maintain these vital functions, including protection of the environment, nature-based solutions and sustainable management of natural resources, enhanced circularity, long-term supply-chain security and access to raw materials. It explicitly recognises how water, soil and other natural resources are crucial for both food supply and economic performance.

The Vision for Agriculture and Food[13] aims to secure the long-term competitiveness and sustainability of the farming and food sector, securing a stable food supply for the European population. One dimension of this entails future-proofing agriculture by promoting sustainable farming practices that reduce emissions, protect natural resources, and improve soil health. This includes:

- supporting the EU's climate objectives through better incentives;
- making sure decarbonisation and competitiveness go hand-in-hand;
- integrating economic and implementation challenges in the ecological transition;
- preserving healthy soils, clean water and air; and
- protecting and restoring the EU's biodiversity.

On biodiversity, the Roadmap towards nature credits aims to stimulate private investment in nature-positive actions across the EU by creating market-based incentives to protect and restore nature. It seeks to reward those who actively contribute to ecosystem restoration and conservation (including farmers, foresters, fishers, landowners, and local communities) and to encourage investors to support these efforts.

In the water domain, the European Water Resilience Strategy aims to restore and protect the water cycle, build a water-smart economy and ensure access to clean water and affordable water for the EU population. Action will focus on improving water management practices and infrastructure, increasing water efficiency, and promoting water re-use and sustainable water use. The Strategy will also promote nature-based solutions to enhance preparedness and resilience, including against natural disasters.

The European Oceans Pact seeks to foster a broader, integrated approach to ocean governance across all sectors, including both internal and external policies. The pact aims to:

- Protect and restore ocean health;
- Boost the competitiveness of the EU sustainable blue economy;
- Support coastal and island communities, and outermost regions;
- Advance ocean research, knowledge, skills and innovation;
- Enhance maritime security and defence; and
- Strengthen EU ocean diplomacy and international ocean governance.

Finally, the EU remains committed to the United Nations (UN) Sustainable Development Goals (SDGs) adopted in 2015 (see Box 2.4).

Box 2.4

The UN Sustainable Development Goals

Sustainability, defined as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'[14], has provided a compass for global development across environmental, social and economic pillars for decades. The 17 SDGs adopted by all UN members in 2015 as part of the UN's 2030 Agenda for Sustainable Development aim to 'provide a shared blueprint for peace and prosperity for people and the planet, now and into the future'.

At the global level, the *Sustainable Development Report 2024*[15] highlights some successes, including reductions in child mortality and HIV infections, and improvements in access to affordable and clean energy and mobile broadband. However, the report reveals that only 17% of the SDG targets are on track, with nearly half showing minimal or moderate progress. At the same time, progress on over one-third has stalled or even regressed.

SDG progress has also been challenged by the COVID-19 pandemic, escalating conflicts, geopolitical tensions and growing climate impacts. The sobering conclusion is that without massive investment and scaled-up action, it will be extremely hard to achieve the SDGs.

2.2 The European Green Deal

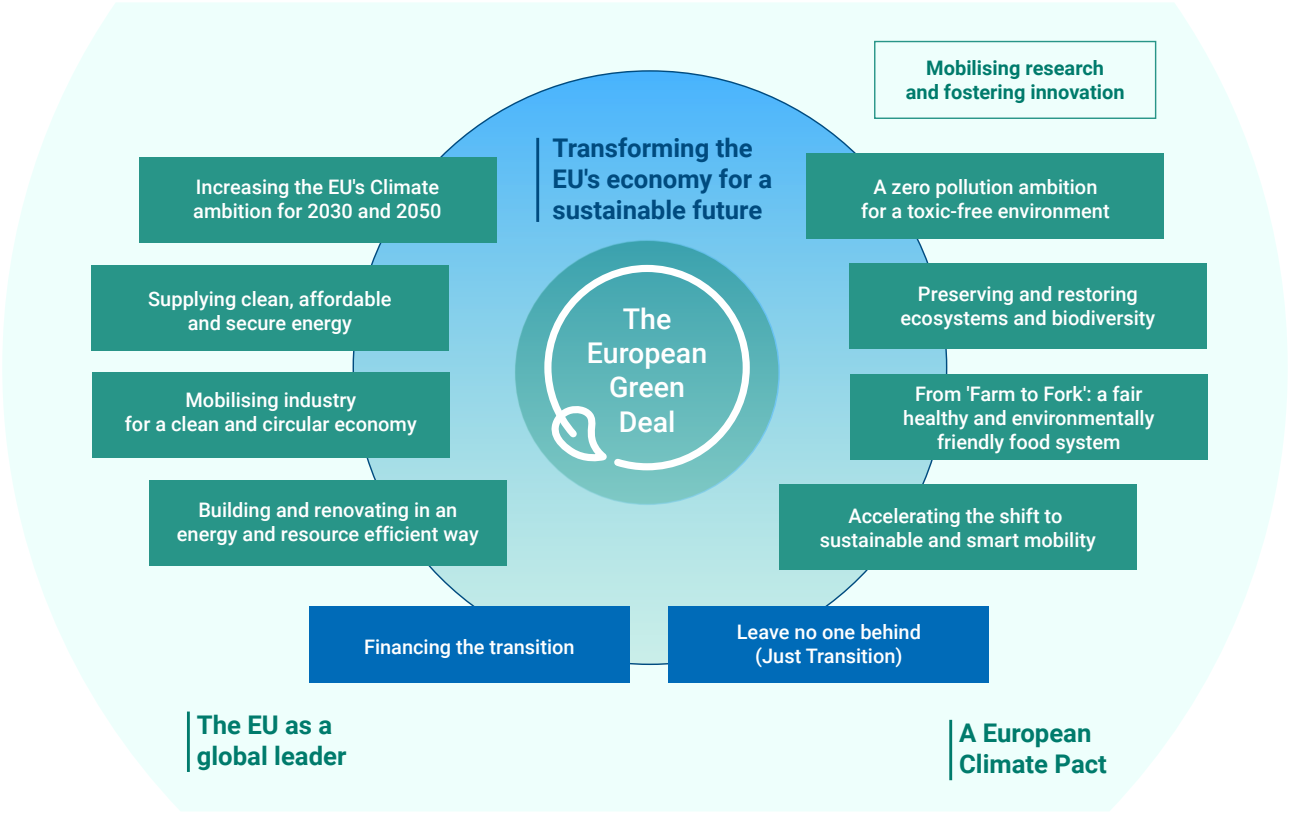
Under EC President Ursula von der Leyen's first mandate, from 2019 to 2024, the legislative agenda was shaped by the aspirations of the European Green Deal (EGD). This ambitious policy package aims to set the EU on the path to becoming the first climate-neutral continent by 2050, with resource use decoupled from economic growth, and no person and no place left behind. It aims to protect, conserve and enhance the EU's natural environment, and protect the health and well-being of citizens in the face of environment-related risks and impacts. At the same time, it aims to ensure that the transition is just and inclusive.

Acknowledging the severity and urgency of climate change and environmental degradation, the EGD reflects the paradigm shift called for by the EEA in its SOER 2020 report[16] by setting out to transform key systems in the European economy. This ambition reaches beyond sectoral approaches to mainstream sustainability

across all policy areas and transform Europe's core production and consumption systems (Figure 2.2). Building on the EGD, the 8th Environment Action Programme (8th EAP) establishes a framework for action on environment and climate policy up to 2030, setting objectives for 2030 and the long-term 2050 objective of living well within planetary boundaries.

In the context of the EC's new mandate, the Political Guidelines for 2024 to 2029 emphasise the ongoing importance of delivering on the legislative commitments agreed-upon under the EGD and of staying the course on its goals. This section provides an overview of legislative developments in the environment and climate policy landscape under the EGD.

Figure 2.2 Strategies under the European Green Deal



Source: EC[17].

Climate neutrality and clean energy

At the core of the EGD is the objective to achieve climate neutrality by 2050, which became a binding target in the EU Climate Law. The Climate Law also requires that, as an intermediate step, net GHG emissions are reduced by at least 55% by 2030 compared to 1990 levels.

The Fit for 55 package established specific objectives to increase the EU's natural carbon sinks, cut methane emissions and capture, transport, use and store carbon dioxide (CO_2).

The EU's Emissions Trading System (EU ETS) was revised in 2023, with a new emissions trading system, ETS 2, to be launched in 2027, covering buildings, road transport and other fuels.

To deliver on the EU's climate ambition, progress has been made around ensuring access to clean, affordable and secure energy. The EC initiative REPowerEU was launched in 2022 in response to the energy crisis caused by Russia's invasion of Ukraine; it has successfully accelerated the transformation to clean energy. Under REPowerEU, the renewable energy directive was revised to include a binding target to increase the share of renewables in the EU's overall energy consumption to 42.5% by 2030, with an ambition to reach 45%.

The energy efficiency directive was also revised, making it binding for EU countries to collectively ensure an additional 11.7% reduction in energy consumption by 2030, compared to the projections in the EU reference scenario 2020. In May 2024, the revised energy performance of buildings directive came into force, focused on increasing the rate of renovation in the EU, particularly for the worst-performing buildings.

The Net-Zero Industry Act aims to enhance European manufacturing capacity for net-zero technologies and their key components, setting a goal for EU manufacturing capacity of net-zero technologies to deliver at least 40% of the EU's annual deployment needs by 2030. By 2030, the act aims to create an EU market for CO_2 storage services. It sets an EU-level goal and sets a target for annual CO_2 storage capacity of at least 50 million tonnes by 2030.

To accelerate the shift to sustainable mobility in Europe, revisions to the EU ETS aim to help reduce emissions from aviation, while the new EU ETS 2 will cover road transport. Under the Fit for 55 policy package, the EU has adopted the regulation on CO_2 emission performance standards. It sets binding targets, notably for a 100% reduction in emissions from new cars and vans by 2035 along with regulations on shipping and aviation. In addition, the emission standards for heavy-duty vehicles set by Regulation (EU) 2019/1242 were revised and the amendments to the regulation entered into force on 26 June 2024.

Adapting to climate change

Ensuring that Europe can adapt to the unavoidable impacts of climate change is a cross-cutting theme in the EGD. The EU Adaptation Strategy, adopted in 2021, aims to make adaptation smarter, swifter and more systemic; it also aims to step up international action on adaptation to climate change. This should primarily be achieved through improved national adaptation strategies and plans. In 2024 the EC responded to the EEA's European Climate Risk Assessment[18] with a communication on managing climate risks. The Communication identified key principles for climate resilience, including:

- Avoiding maladaptation to ensure that resilience measures do not shift risks onto others or worsen future risks;
- Systemic action involving cross-sectoral solutions to address interlinked climate risks; and
- Transformational change to ensure that adaptation is ambitious, inclusive, and does not lead to social and economic disparities.

Additionally, the EU has increased funding to support people and regions affected by increasingly frequent climate events through the EU Solidarity Fund, NextGenerationEU and the EU Civil Protection Mechanism.

Zero pollution and a circular economy

To deliver on the ambition for a zero-pollution ambition for a toxic-free environment, the Zero Pollution Action Plan was adopted in 2021, establishing targets to speed up pollution reduction at source. Under this umbrella, the revised urban wastewater treatment directive, ambitious new rules for ambient air quality and the Euro 7 regulation have all been adopted, while new rules have been agreed on toy safety and on detergents and surfactants.

Progress was made on reducing microplastic pollution; restrictions on microplastics being added to products have been adopted and a proposal has been made to introduce further measures to prevent pellet losses in the environment.

The EC's Chemical Strategy for Sustainability sets out the goal to better protect people and the environment from hazardous chemicals. Additionally, actions are ongoing to promote the EC's assessment framework safe and sustainable by design chemicals and materials, with the development of a European assessment framework[19] and methodological guidance[20].

The role of industry as an enabler for a clean and circular economy is also prominent. The Circular Economy Action Plan, announced in 2020, aims to decouple economic growth from resource use, and shift to circular systems in production and consumption.

Since then, EU regulations on the ecodesign for sustainable products, batteries, construction products and packaging have come into force, along with proposals to reduce food waste. The Strategy for Sustainable and Circular Textiles, communicated in 2022, aims to create a coherent framework to address the growing impact of textiles on the environment by changing the way they are produced and consumed.

The Critical Raw Materials Act aims to ensure secure and sustainable supplies of critical raw materials for Europe's industry. It aims to increase resilience by reducing dependencies on imports from single country suppliers, increasing preparedness – for example through the build-up of strategic stockpiles, and promoting supply chain sustainability and circularity. It identifies a list of critical raw materials and a list of strategic raw materials, crucial for technologies for the green and digital transition. The Act sets benchmarks for domestic capacities along the strategic raw material supply chain to be reached by 2030, at 10% of the EU's annual needs for extraction and at 40% for processing and 25% for recycling. No more than 65% of EU's annual needs for each strategic raw material at any relevant stage of processing should come from a single third country.

Protecting and restoring ecosystems and biodiversity

The Biodiversity Strategy for 2030 is a long-term plan to put biodiversity on the road to recovery by 2030. To deliver on the Strategy's goals, the nature restoration regulation, adopted in 2024, aims to restore ecosystems, habitats and species across the EU's land and sea areas and sets binding targets for specific habitats and species, with measures to cover at least 20% of the EU's land and sea areas by 2030, and ultimately all ecosystems in need of restoration by 2050. The regulation contains the following specific targets:

- improving and re-establishing biodiverse habitats on a large scale, and bringing back species populations by improving and enlarging their habitats;

- reversing the decline of pollinator populations by 2030, and achieving an increasing trend for pollinator populations, with a methodology for regular monitoring of pollinators;
- achieving an increasing trend for standing and lying deadwood, uneven aged forests, forest connectivity, abundance of common forest birds and stock of organic carbon;
- preventing any net loss of green urban space and tree cover by 2030, and a steadily increasing their total area from 2030;
- increasing populations of grassland butterflies and farmland birds, the stock of organic carbon in cropland mineral soils, and the share of agricultural land with high-diversity landscape features, as well as restoring drained peatlands under agricultural use;
- restoring marine habitats such as seagrass beds or sediment bottoms that deliver significant benefits, including for climate change mitigation, and restoring the habitats of iconic marine species such as dolphins and porpoises, sharks and seabirds; and
- identifying and removing barriers to the connectivity of surface waters, so that at least 25,000 km of rivers are restored to a free-flowing state by 2030.

A provisional agreement has also been reached on a directive establishing a framework for soil monitoring.

Sustainable investment

The EC has pledged to mobilise at least EUR 1 trillion in sustainable investments over the next decade, with the EU Taxonomy providing a definition of economic activities that can be considered environmentally sustainable for financial and non-financial companies. The EU budget for 2021-2027 plays a key role in supporting the green transition. By 2027, the EU is expected to have allocated EUR 658 billion to climate action, accounting for 34.3% of the EU's overall budget.

To leverage private sector investment in green and sustainable projects, sustainable finance measures such as the taxonomy regulation and the voluntary green bond standard have been implemented. Under the corporate sustainability reporting directive (CSRD) a broader set of large companies, as well as listed SMEs, are required to report on sustainability, enabling investors and other stakeholders to assess companies' impact and to judge financial risks and opportunities arising from climate change and other sustainability issues.

Research and innovation

The EU's key funding programme for research and innovation, Horizon Europe, runs up to 2027 and fosters the development of technologies, solutions and disruptive innovations needed to transform Europe's economy towards sustainability. Horizon Europe is key to leveraging national public and private investment in research and innovation, with over 35% of spending allocated to addressing climate change, while 10% of the budget from 2025 to 2027 is committed to biodiversity. The EC made EUR 1 billion available under the EGD research and innovation call — the last and biggest call under Horizon 2020.

A just transition

Europe is committed to building a fair and inclusive society, as set out in the European Pillar of Social Rights. Recognising that social and environmental problems facing Europe are interwoven[21], the EGD acknowledges the need to transition towards sustainability in a just manner, ensuring no one is left behind. The Council recommendation on ensuring a fair transition towards climate neutrality invites Member States 'to adopt and implement, in close cooperation with social partners as relevant, comprehensive and coherent policy packages, addressing the employment and social aspects to promote a fair transition across all policies, notably climate, energy and environmental policies'[22].

In December 2023 the EC published its EU-wide assessment of the draft updated national energy and climate plans[23], stressing the need for Member States to adopt more comprehensive just transition strategies.

A central tool for achieving this just transition is the Just Transition Mechanism. Around EUR 55 billion has been earmarked for the 2021-2027 period for the most affected regions, to alleviate the socio-economic impact of the transition. The Just Transition Fund is the first pillar of the mechanism and supports the economic diversification and reconversion of affected territories, including for example re-skilling workers, promoting clean energy and transforming carbon-intensive installations.

Additionally, as part of the Fit for 55 package, the Social Climate Fund was established to mitigate the social and distributional impacts of the new ETS 2 for buildings and road transport, providing targeted support to vulnerable groups, particularly households that struggle to pay their energy and transport bills. Together with a mandatory 25% contribution by Member States to their social climate plans, the Social Climate Fund should mobilise at least EUR 86.7 billion of public funds over the 2026-2032 period.

2.3 Implementation to cut costs and deliver a level playing field

The environmental and climate legislation agreed under the last mandate has the potential to deliver significant progress if implemented and enforced. The onus now falls on Member States to fully implement the legislation that has been agreed over the past 5 years. Failed or weak implementation means that environment and climate impacts persist, public trust is undermined, and businesses compete on an uneven playing field.

According to the EC's 2025 Environmental Implementation Review, the costs of failure to implement EU environmental laws through air and water pollution, nature degradation and waste are estimated at EUR 180 billion per year for the EU; approximately 1% of EU GDP. Effective and full implementation of environmental policies could cut these costs, while ensuring a level playing field for companies across the EU single market[24].

A recent report from the EC's Joint Research Centre provides a comprehensive assessment of progress towards 154 binding and non-binding policy targets set out under the EGD. Targets cover key sectors, including climate, energy, circular economy, transport, agriculture and food, ecosystems and biodiversity, water, soil and air pollution. There has been progress on 62% of targets and 21% are well on track. As of mid-2024, 32 of the 154 targets are currently 'on track', 64 fall into the 'acceleration needed' category and 15 are found to be 'not progressing' or 'regressing'. For 43 of the targets, no data are currently available[25].

2.4 The EU's global role around the environment and climate

The EU's ambitious climate targets and high environmental standards have made Europe a credible leader and advocate for increased ambition globally. On the international stage, the EU has been active in securing multi-national agreements that provide the foundation for global action on climate change and biodiversity loss. The EU has led the way on climate change, contributed to the United Nations Framework Convention on Climate Change (UNFCCC) processes and played a key role in securing the Paris Agreement. The EU was also a driver of the Kunming-Montreal Global Biodiversity Framework[26]. Furthermore, it is involved in ongoing negotiations to develop a global agreement on plastics pollution[27].

Box 2.5

The Paris Agreement and the Kunming-Montreal Global Biodiversity Framework

The Paris Agreement (2015)

The Paris Agreement, adopted under the UNFCCC, is a cornerstone of global climate action. It aims to:

- limit global temperature rise to well below 2°C and pursue efforts to limit it to 1.5°C;
- enhance resilience and strengthen adaptation to climate impacts and reduce vulnerabilities; and
- mobilise public and private investments in support of low-emission, climate-resilient pathways.

The agreement requires countries to submit and update Nationally-Determined Contributions (NDCs) every 5 years to ensure progress and ambition. The EU submitted its updated NDC in December 2023 and will submit an updated version in 2025.

The Kunming-Montreal Global Biodiversity Framework (2022)

The Kunming-Montreal Global Biodiversity Framework, adopted under the Convention on Biological Diversity, aims to halt and reverse biodiversity loss. It includes four long-term goals for 2050: 'Protect and Restore', 'Prosper with Nature', 'Share Benefits Fairly' and 'Invest and Collaborate'. It also sets 23 targets to be achieved by 2030, including to protect 30% of terrestrial and marine areas and to mobilise at least EUR 150 billion per year.

The EU submitted its implementation targets in 2024 and will report on its progress by February 2026.

To reduce European consumers' impact abroad and encourage further action on sustainability in trading partner countries, the EU has also adopted two landmark initiatives. The Regulation on Deforestation-free Products aims to ensure that products bought, used and consumed by European citizens do not contribute to deforestation or forest degradation worldwide. Initially scheduled to apply from 30 December 2024, its application has been delayed. The regulation will be binding from 30 December 2025 for large operators and traders, while micro- and small companies will have to apply it as of 30 June 2026.

The carbon border adjustment mechanism (CBAM) will apply from 2026 and aims to prevent carbon leakage by ensuring that the carbon price of imports is equivalent to the carbon price of domestic production (see Box 2.6).

Box 2.6

Carbon border adjustment mechanism

The EU's CBAM was introduced in 2023 and aims to reduce carbon emissions, put a fair price on the carbon emitted during the production of carbon-intensive goods imported into the EU, and encourage cleaner industrial production in third countries. By confirming that a price has been paid for the carbon emissions embedded in imports of certain goods, the CBAM will ensure the carbon price of imports is equivalent to the carbon price of EU production and that the EU's climate objectives are not undermined.

The CBAM will apply from 2026, with the current transitional phase running from 2023 to 2025. This gradual introduction of the CBAM is aligned with the phase-out of the allocation of free allowances under the EU ETS to support the decarbonisation of EU industry. The CBAM will initially apply to products with a high risk of carbon leakage, such as iron and steel, cement, fertilisers, aluminium, hydrogen and electricity.

Building on the experiences gained during the transitional phase, CBAM will be simplified to reduce the administrative burden on industries and their supply chains while continuing to incentivise global carbon pricing. At the same time, the EC will propose further amendments to the CBAM regulation to extend the scope to further downstream products and introduce additional anti-circumvention measures.

In parallel, the EU continues to further support the decarbonisation efforts of partner countries through technical assistance and regulatory cooperation. For example, the International Carbon Markets and Carbon Pricing Diplomacy Task Force supports partner countries in developing effective carbon pricing policies and robust approaches to international carbon markets.

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3 Europe's environment and climate: state and outlook

Key messages

- Europe is the fastest-warming continent in the world and its climate is changing at an alarming rate, threatening security, public health, ecosystems, infrastructure and the economy. Over 240,000 people died because of weather- and climate-related extreme events from 1980 to 2023 in the EU-27. Weather- and climate-related extremes caused economic losses estimated at EUR_{2023} 738 billion in the EU-27 from 1980 to 2023, with over EUR_{2023} 162 billion in costs from 2021 to 2023 alone. The insurance protection gap across Europe is substantial, with most countries reporting over 50% of losses as uninsured.
- Managing the climate crisis requires a dual approach: increasing resilience and mitigating climate change. Europe must accelerate its implementation of adaptation measures to avoid future costs and consequences linked to climate change. At the same time, it must continue to reduce greenhouse gas emissions and increase carbon removals.
- Europe is a world leader in mitigating climate change. The EU has successfully cut net domestic greenhouse gas emissions by 37% since 1990, due to reductions in fossil fuel use and doubling the share of renewables since 2005. This provides a model for how climate action can boost competitiveness and energy security by lowering dependency on imported fossil fuels and increasing the share of domestically produced renewable energy.
- Biodiversity is in poor condition across terrestrial, freshwater and marine ecosystems in Europe due to persistent pressures from production and consumption systems, most notably the food system. Overall, 81% of protected habitats are in a poor or bad state, 60-70% of soils are degraded and 62% of water bodies are not in good ecological status. Past policy targets have not been met and it is unlikely that 2030 targets will be achieved. Climate change impacts are expected to intensify and exacerbate other pressures on biodiversity.
- The degradation of aquatic ecosystems threatens Europe's water resilience. Water stress affects 30% of the European territory and 34% of the population. Climate change will exacerbate water stress, potentially leading to competition for water resources. Water availability is key to ensuring Europe's security and competitiveness in the future.
- Preventing pollution reduces the burden of death and disease: EU policies to improve air quality have saved lives, with a 45% reduction in premature deaths attributable to fine particulate matter ($PM_{2.5}$) from 2005 to 2022. Nevertheless, pollution continues to reduce quality of life in Europe significantly, with at least 10% of premature deaths in Europe driven by exposure to polluted air, water and soil, noise and harmful chemicals.
- The greatest impacts from environmental risks to health fall on socio-economically deprived groups and vulnerable groups such as children, the elderly, the chronically ill and people with disabilities.

Introduction

This chapter provides a science-based assessment of the state and outlook for Europe's environment and climate. The assessment covers three topics:

- biodiversity and ecosystems;
- climate change mitigation and adaptation; and
- pollution and environmental health.

For each topic, answers are provided to the following questions:

- What is covered in the assessment of each area?
- Why is it important to the European population?
- What is the EU doing in the area?
- What is the current state at the European level?
- What were the trends over the past 10 to 15 years?
- What is the outlook for the next 10 to 15 years?
- What are the prospects of meeting current EU policy targets?
- What are the main drivers and pressures — especially from economic sectors — that lie behind the trends?

The evidence presented here is based on the thematic briefings of *Europe's environment 2025*, which in turn are based on the latest quantitative data formally reported to the European Environment Agency (EEA) by its member countries across Europe. It provides the most robust, credible and up-to-date assessment available of Europe's environment and climate.

3.1 Biodiversity and ecosystems

3.1.1 Introduction

What is covered?

The term 'biodiversity' refers to the variety of life on Earth, including diversity within species, between species and across ecosystems. This section examines the current state of biodiversity and habitats across terrestrial, freshwater and marine ecosystems in Europe. It builds on evidence from the briefings under the theme biodiversity and ecosystems, describes the main pressures and explains why Europe is not on track to halt the loss of biodiversity.

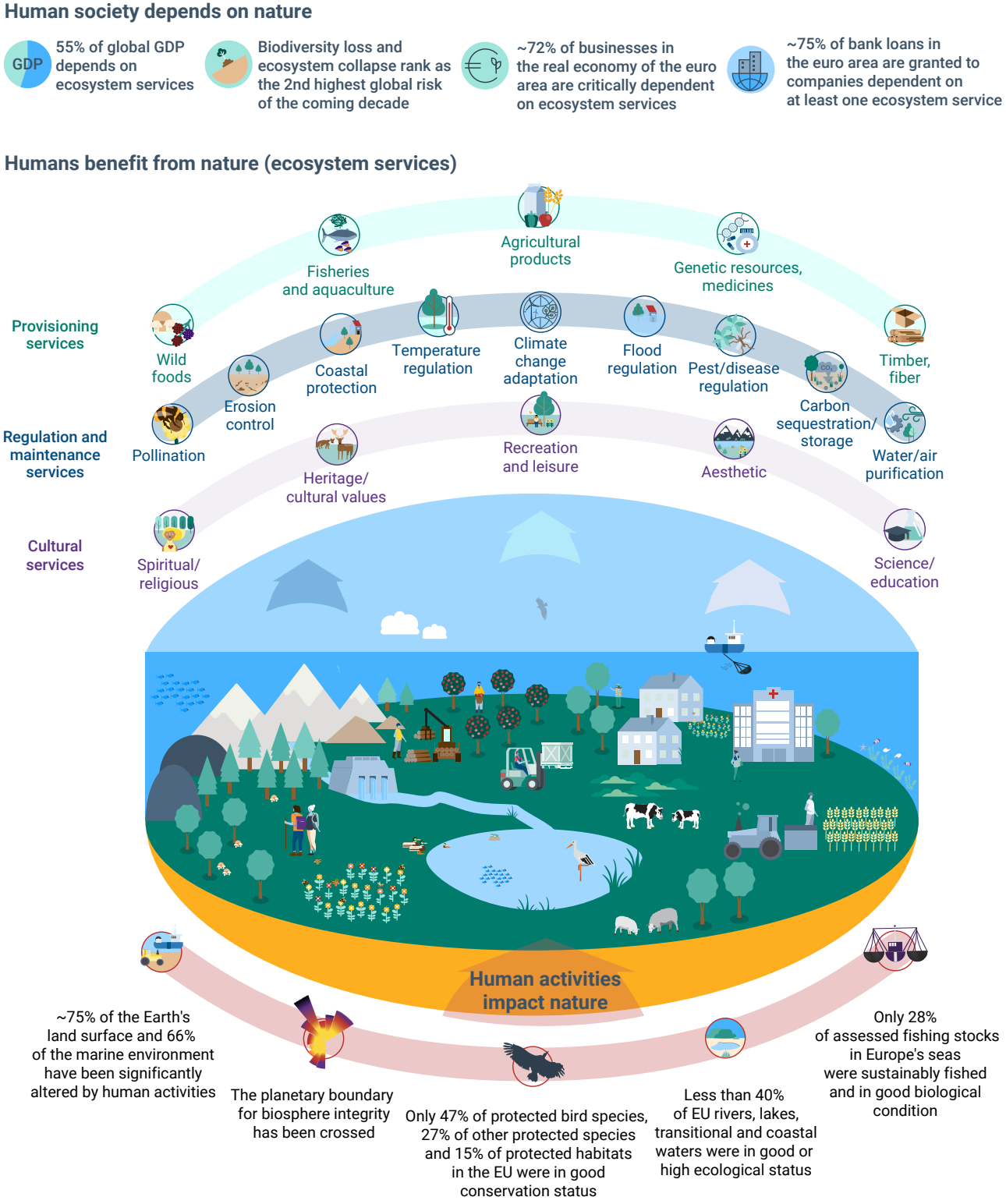
Why is it important?

Biodiversity and ecosystems are vital for sustaining life on Earth, providing a wide range of essential goods and services that support society, the economy, and human health and well-being. These ecosystem services can be divided into three categories — provisioning, regulating/maintaining and cultural services (Figure 3.1). Despite this, human activities are driving an unprecedented loss of biodiversity and ecosystem degradation, with biosphere integrity among the six planetary boundaries that have already been transgressed[1].

How do ecosystem services underpin the EU economy? Up to 36% of the EU's gross value added significantly depends on nature[2]. The European Central Bank has estimated that nearly 75% of all bank loans in the euro area are to companies that are highly dependent on at least one ecosystem service[3]. Without functioning ecosystems, businesses face disruptions, increased costs and financial vulnerabilities.

Protecting nature is an economic necessity, vital for water and food security, and a key tool in mitigating and adapting to climate change.

Figure 3.1 **Ecosystems services — benefits and costs**



Source: EEA, 2025.

What is the EU doing?

The EU has a robust framework of environmental legislation in place aimed at protecting and restoring biodiversity and habitats across terrestrial, freshwater and marine ecosystems. The measures include the habitats and birds directives, the water framework directive, the marine strategy framework directive (MSFD) and the invasive alien species regulation.

The European Green Deal aimed to strengthen this framework with initiatives such as the EU Biodiversity Strategy for 2030, the EU Forest Strategy for 2030, the EU Soil Strategy for 2030, the EU pollinators initiative and the zero pollution action plan (ZPAP). Recently, the EU also adopted the nature restoration regulation (NRR), which is a significant addition to EU environmental legislation (Box 3.1).

In addition, a provisional agreement has been reached on a directive establishing a framework for soil monitoring. It is also foreseen that a new EU Bioeconomy Strategy, which should ensure a sustainable supply of biomass and its use in line with circularity principles, will be adopted by the end of 2025.

The EU Biodiversity Strategy for 2030 aims to put Europe's biodiversity on the path to recovery by 2030 and contains specific commitments and actions to be delivered by 2030. Many sectoral policies also have an important impact on biodiversity, such as the Common Agricultural Policy (CAP), the Common Fisheries Policy (CFP), the Sustainable Blue Economy and the recent Vision for Agriculture and Food.

Box 3.1

The nature restoration regulation

The nature restoration regulation (NRR), which entered into force on 18 August 2024, aims to restore a wide range of degraded ecosystems, habitats and species across both land and sea areas within the EU.

Overall, the NRR aims to contribute to:

- the recovery of biodiverse and resilient ecosystems;
- climate change mitigation and adaptation;
- the reversal of land degradation;
- food security; and
- the achievement of the EU's international commitments.

The overall objective at EU level is to put in place restoration measures on at least 20% of the EU's land and 20% of its sea areas by 2030, and in all ecosystems in need by 2050.

To meet these goals, the NRR sets out specific, legally-binding targets that cover habitats already protected under existing EU legislation and in need of restoration, as well as e.g. agricultural, urban and forest ecosystems (see Chapter 2).

Each Member State will submit its draft national restoration plan (NRP) by September 2026 to the European Commission. The NRPs will then be reviewed to ensure they adequately meet the targets and obligations set under the NRR. Final NRPs should be submitted and published by September 2027.

Source: EC[4].

The global dimension

The biodiversity crisis is global. It is declining faster than at any time in human history[5]. Biodiversity loss transcends national borders and actions in one region can have cascading impacts elsewhere. In our globalised economy, international trade often exacerbates biodiversity loss and ecosystem degradation, typically in regions far from where goods are consumed. For example, 80% of recent global land-use change impacts — a major driver of global biodiversity loss — are linked to increased agri-food exports from biodiversity-rich regions[6].

Europe's imports of resources from around the world significantly contribute to biodiversity decline beyond its borders — a reality not always apparent to the average consumer. For example, between 2008 and 2017, nearly 6% of tropical deforestation was linked to the production of palm oil, meat, soy, cocoa, maize, timber, rubber and biofuels that were imported to the EU[7].

It is imperative that the EU and its Member States monitor and reduce the external pressure they place on biodiversity, habitats and ecosystems. Indeed, the EU has recently enacted legislation to mitigate its impact on biodiversity beyond Europe's borders, such as the regulation on deforestation-free products. At the global level, the EU and its Member States are part of the Kunming-Montreal Global Biodiversity Framework which sets out ambitious policy targets (Box 2.5 in Chapter 2); these include conserving at least 30% of terrestrial, inland water, and coastal and marine areas by 2030.

What is the current state at the European level?

Table 3.1 compiles past trend assessments over the last 10 to 15 years, outlooks 10 to 15 years ahead, and assessments of the prospects of meeting 2030 and 2050 EU policy targets (where in place) from the eight thematic briefings on biodiversity and ecosystems. Details on the assessments, as well as on cross-cutting drivers and pressures, are provided in Sections 3.1.2 to 3.1.4.

Table 3.1 Overview of assessment results on biodiversity and ecosystems

Briefing	State of Europe's biodiversity	Pollution of ecosystems	Protected areas	Water and climate impacts	Ecosystems and climate impacts	Land use and land take	Soil resources	Biodiversity investment needs
Past trends (10-15 years)								
Outlook (10-15 years)								
Prospects of meeting EU policy targets for 2030								
Prospects of meeting EU policy targets for 2050								

Improving trends (are expected to) dominate/largely on track to meet policy targets

Trends (are expected to) show a mixed picture/partially on track to meet targets/highly uncertain

Deteriorating trends (are expected to) dominate/largely not on track to meet policy targets

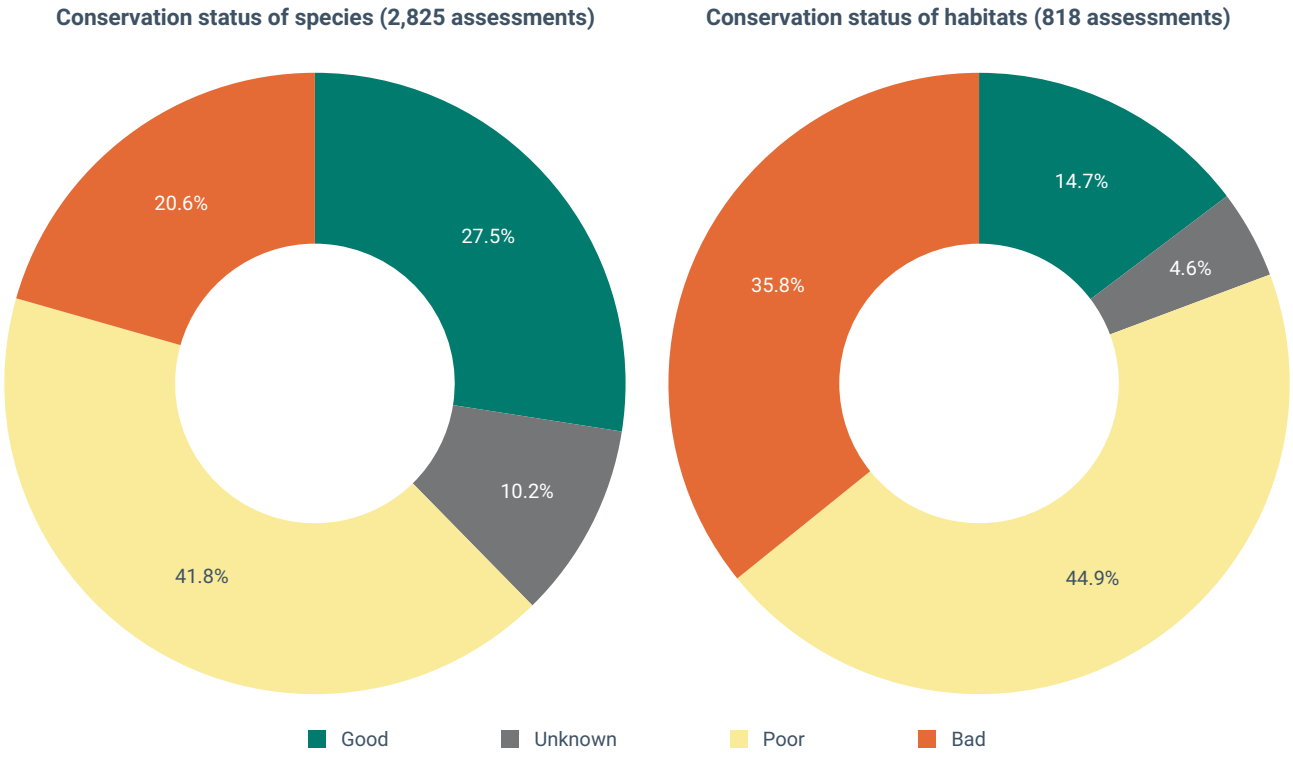
No specific policy targets

Source: Biodiversity and ecosystem briefings of *Europe's environment 2025*.

3.1.2 Past trends

Biodiversity in Europe has been declining, with the evidence indicating that biodiversity is in a poor state across terrestrial, freshwater and marine ecosystems (for details see briefing 'State of Europe's biodiversity'). Reporting from the birds and habitats directive for the period 2019-2024 will only be published in 2026. However, the previous reporting period (2013-2018) showed that 62% of protected species (not comprising bird species) and 81% of protected habitats (Figure 3.2), and 39% of protected bird species, were in a poor or bad conservation status at the EU level During the same period, 30% of protected bird species had decreasing trends, while 35% of all protected non-bird species and 36% of all protected habitats not in god status had deteriorating trends[8]. Long-term trends also show that between 1990 and 2023, the index of 168 common birds decreased by 15% in the EU[9]. Meanwhile, the grassland butterfly index in Europe shows that between 1991 and 2020, populations of 15 grassland butterfly species decreased significantly, by 29.5%[10]. In addition, a dramatic decline in insects over decades has been documented; in some protected areas, insect numbers have decreased by 75%[11]. Similarly, the EU ecosystem assessment shows that ecosystem conditions were generally poor, due to constant pressure[12].

Figure 3.2 **Conservation status of species (left) and habitats (right) under protected the EU Habitats Directive**



Source: EEA[13,14].

Only 38% of rivers, lakes, and transitional and coastal waters had a good or high ecological status in 2021. In fact, this figure has remained largely unchanged since 2015[15]. Similarly, the EU's marine ecosystems continued to show signs of degradation and a loss of resilience, with a high proportion of marine mammals, fish, birds and habitats not meeting 'good environmental status' criteria. Trends over time

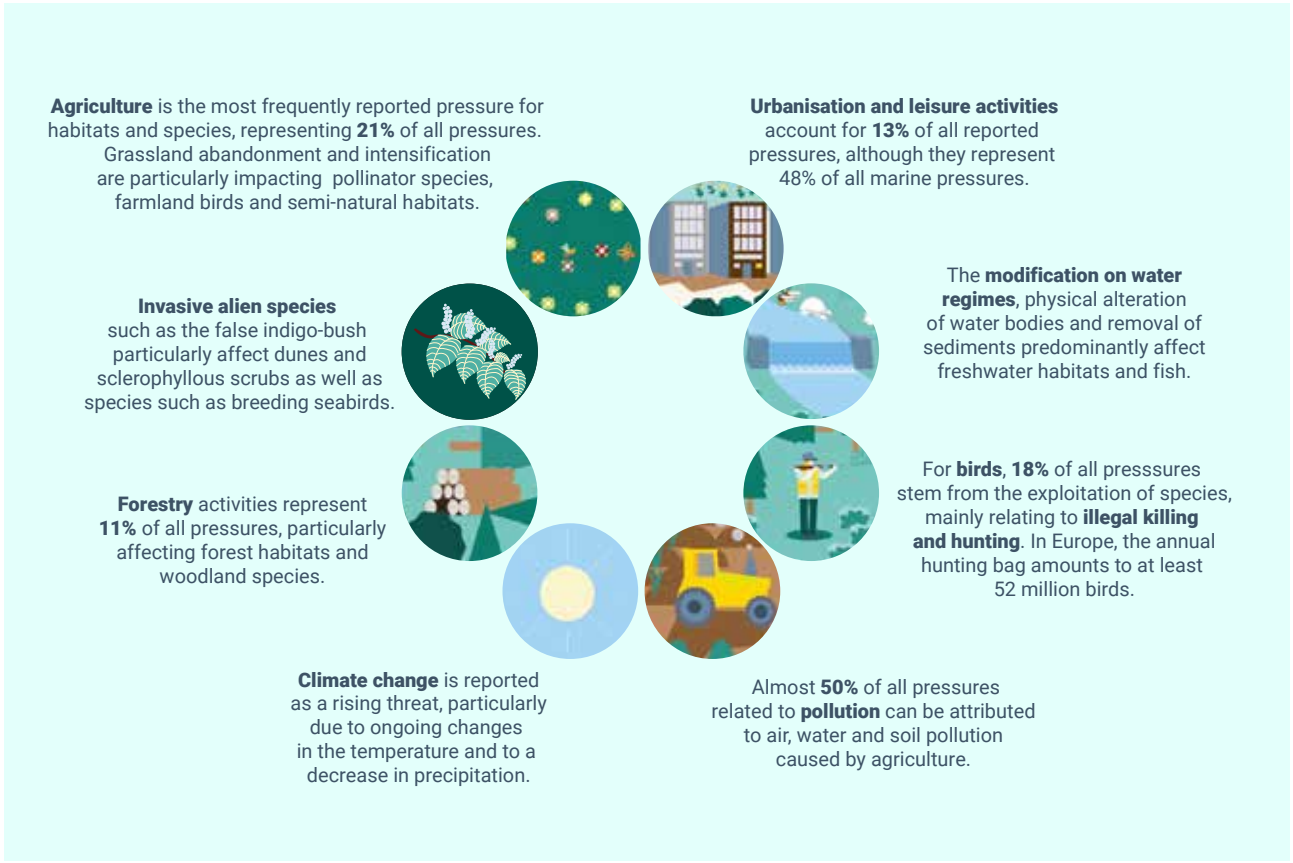
in marine ecosystems were either declining or stable, as reported in 2018[16]. The status of soils was also concerning, with 60-70% currently degraded, particularly in agricultural areas but also in many wetlands and some forest areas (for details see briefing 'Soil resources').

This general poor status of species and habitats across ecosystems can largely be attributed to high human pressures, leading to cumulative impacts that cause degradation and loss of function and structure that reduce overall ecosystem resilience. Figure 3.3 shows the key pressures reported for the nature directives. The pressures can be grouped into five main categories:

- changes in land and sea use;
- overexploitation of natural resources;
- climate change;
- pollution; and
- invasive alien species (IAS).

The cumulative impacts from these pressures continue to be a significant threat to biodiversity and habitats across terrestrial[8], freshwater[14,15] and marine[17] ecosystems.

Figure 3.3 **Key pressures on biodiversity based on reporting for the nature directives**



Note: The term 'nature directives' refers collectively to the birds and habitats directives.

Source: EEA[8].

Changes in land and sea use

These changes have continued to disrupt habitats important for biodiversity. For example, land take — the conversion of natural and semi-natural land into artificial land such as settlements or commercial areas — increased by about 14% between 2005 and 2021 in the EU-27 (for details see briefing 'Land use and land take'). In freshwater environments, in 2021, changes to natural flow and function, for example, from barriers and wetland draining, impacted about 50% of Europe's surface waters, with adverse effects on aquatic biodiversity[15].

The marine environment is increasingly impacted by sea use change[18]. This is due to activities like maritime transport[19] and disturbances to the seabed from bottom trawling[18]. The growth in offshore renewable energy production highlights the importance of balancing nature protection with developing more sustainable and secure energy sources[20].

Overexploitation of natural resources

Unsustainable agricultural practices and overexploitation of natural resources such as sand, gravel and water have driven the degradation of ecosystems. The pressures on both habitats and species that were most frequently reported by countries stem from agriculture[21].

At the same time, overexploitation through persistent overfishing threatens Europe's marine ecosystems, food security and biodiversity[22]. Water abstraction in the EU decreased by 19% from 2000 to 2022 as reported by Member States. However, water stress still affects about 30% of the EU land and 34% of the EU population each year[23].

Climate change

Climate change is a significant driver of biodiversity loss and ecosystem degradation across marine, freshwater and terrestrial ecosystems[24] (for details see briefing 'Ecosystems and climate impacts'). Climate change is also increasing the risks to water security by exacerbating water scarcity, drought and floods, thereby compromising water resilience (for details see briefing 'Water and climate impacts').

Changes in temperature, precipitation patterns and aridity have all been causing extreme weather events, such as droughts, floods and heatwaves. They have also driven shifts in species distribution, such as changes in fish distribution in Europe's seas[25], as well as ocean acidification and larger wild forest fires. These changes degrade habitats across terrestrial, freshwater and marine ecosystems[26] in Europe, undermining the resilience of ecosystems[26]. Risks to coastal and marine ecosystems are considered the most severe in the near term (2021-2040) and entail the highest urgency to act[24].

Climate change threatens to degrade ecosystems to the point at which critical tipping points are crossed; for example, boreal forests could suffer dieback at their southern edge, while expanding on the tundra to the north[27].

Pollution

The trends in pressures from pollution on biodiversity and ecosystems are mixed, with progress in some areas and ongoing challenges in others (for details see briefing 'Pollution of ecosystems'). For example, chemical pressures in some marine regions have decreased[28,29] as has the share of terrestrial habitats affected by air pollution[30]. Yet, pollution remains a major risk to biodiversity and habitats

across ecosystems, particularly from nutrients and pesticides used in agriculture and microplastics.

Emissions of nitrogen oxides (NO_x), sulphur dioxide (SO_2) and heavy metals have declined significantly in recent decades. However, ammonia (NH_3) emissions have remained persistently high in many areas and ozone (O_3) continues to pose a widespread risk[31].

By 2021, only 30% of surface waters were classified as having good chemical status. This was primarily due to a few persistent pollutants such as mercury (Hg) and brominated flame retardants[15,32]. Between 2010 and 2022, of the nine hazardous substances monitored in marine organisms, benzo(α)pyrene, lindane (y-HCH) and polychlorinated biphenyl (PCB) exceeded safe limits. Available time trends show that regions with decreasing concentrations are more prevalent than increasing ones, however[29].

The monitoring and control of pollution becomes more complicated as emerging chemicals move into widespread use and spread in the environment.

Invasive alien species (IAS)

IAS are animals and plants introduced into natural environments where they do not naturally occur. They have negative impacts on biodiversity and ecosystem services. IAS are one of the five most significant direct drivers of biodiversity loss. For example, the average annual rate of new occurrences of non-indigenous species in Europe's seas has been increasing, threatening marine biodiversity[33]. Several IAS also represent a risk for human health by transmitting diseases. Overall, IAS are costly to society: according to one estimate from 2023, they cost the EU EUR 26.64 billion per year, and this figure is projected to increase[34]. Under the EU's invasive alien species regulation, there is a list of 88 species of concern across the Union — 47 animals and 41 plants — that are subject to restrictions and control measures aimed at preventing their spread and reducing their impact. For example, the Chinese mitten crab (*Eriocheir sinensis*), which has established in 18 EU Member States, causes significant ecological and socio-economic damage, such as harming fisheries and aquaculture[35].

Interactions of key pressures

The five key pressures on biodiversity — land- and sea-use change, direct exploitation of organisms, climate change, pollution and IAS — are often interconnected and can have cumulative or synergistic effects, meaning their combined impact is greater than the sum of their individual effects. In particular, climate change exacerbates other pressures.

For example, land-use change is driven by increased fire and drought risk, warm conditions aid the spread of invasive species and pollution run-off during high levels of precipitation drives a process referred to as eutrophication, where aquatic environments become overly enriched with nutrients leading to an excessive growth of algae. In addition, these pressures can disrupt the structures of ecological networks and thereby increasing the risk of cascading extinctions[36].

The degradation of biodiversity and habitats across terrestrial, freshwater, coastal and marine ecosystems is interconnected. For example, the lack of progress in improving the ecological status of rivers, lakes, coastal waters and marine waters in Europe has largely been caused by persistent pressures on surface waters and terrestrial ecosystems.

These persistent pressures include diffuse pollution from agriculture, degraded forests and altered soil conditions. This pollution results in modifications to the quality of the surface and groundwater and thus impacts whole ecosystems negatively. Marine litter, predominantly originating from land-based sources, is an additional pressure. It is transported through rivers and waterways, ultimately affecting marine ecosystems[37]. The Baltic Sea offers an example of such cascading effects: biodiversity trends in the marine ecosystems of the Baltic Sea, which are sensitive to land-based pollution, have shown little to no improvement[38].

These interlinkages underscore the importance of embracing a holistic 'source-to-sea' approach — managing water resources and related issues across the entire connected system from the source of a river to its outlet in the ocean — when addressing environmental challenges, in recognition that interventions in the source area of a river can significantly influence environments in areas far away, such as a river delta[37].

Over the last decade, there has been an increase in the extent of protected areas — a cornerstone measure for preserving biodiversity and ecosystems. In 2022, 26.1% of the EU's land and 12.3% of its seas were protected (for details see briefing 'Protected areas'). While this expansion is promising, designating protected areas alone does not guarantee that biodiversity is safeguarded effectively.

Many protected areas face pressures from tourism, agriculture, fisheries and infrastructure development, which can undermine conservation goals. It is crucial that these protected areas are ecologically representative, well-managed, and spatially and functionally well-connected so that they can deliver tangible benefits to biodiversity and ecosystems.

Biodiversity investment within the EU and its member states, including international contributions, rose from EUR_{2024} 23 billion in 2014 to EUR_{2024} 31 billion in 2019. Despite this increase, funding remains at the lower end of the estimated EU annual need (for details see briefing 'Biodiversity investment needs' and Section 6.3).

3.1.3 Outlook and prospects for meeting policy targets

Most pressures on Europe's biodiversity and ecosystems remain high, raising serious concerns about their future and the EU's terrestrial, freshwater and marine ecosystems over the next 10 to 15 years. Species and habitats continue to experience substantial pressures from human activities, such as resource extraction, infrastructure development and tourism. This is compounded by the escalating impacts of climate change.

The natural flows and physical characteristics of surface waters continue to be altered by activities including flood protection measures, agriculture and barriers from old, often obsolete, infrastructure[15]. Additionally, Europe's seas face increasing pressures from the growing 'blue economy' — all industries and sectors related to the use of oceans, seas and coasts, with impacts exacerbated by climate change[18].

The outlook for pollution is mixed. It is anticipated that chemical and plastic pollution, as well as air deposition, will decrease, although eutrophication remains a significant challenge. Diffuse pollution will continue to be a problem, though enhanced control measures for urban wastewater and industrial emissions could reduce point-source pollutants, such as industrial plants. Marine eutrophication is expected to remain considerable; improvements in urban wastewater management will potentially be offset by agricultural nutrient runoff and sea warming. Soil pollution should decline

due to reduced industrial emissions, air deposition and ozone precursor emissions, though ongoing agricultural activities could hinder further improvements.

Europe will increasingly face severe climate impacts, including droughts, floods, heatwaves and rising sea levels. These will impact both Europe's water resilience and the health of Europe's biodiversity and ecosystems.

A number of challenges are anticipated in relation to water resilience. Prolonged droughts will become more frequent, worsening water stress, particularly in southern Europe[39]. Reduced snow cover and earlier snowmelt will exacerbate droughts and flooding, intensifying economic competition for scarce water resources. River and coastal flooding will increase, causing saltwater intrusion and reducing groundwater quality[15,40].

Key adaptation actions include reducing water abstraction, improving water circularity, enhancing water retention and restoring ecosystems. However, these measures alone will not eliminate climate risks. Preparedness, effective emergency responses, and adaptive societal and economic practices remain essential for reducing Europe's vulnerability[15].

Terrestrial, freshwater and marine ecosystems face serious climate-induced threats, including changes in migration patterns and species distribution, ocean acidification, habitat loss from changing land use and rising sea levels[24]. Arctic ecosystems face unprecedented warming, with nearly ice-free summers projected by 2050[41]. Longer fire seasons with greater areas which are fire-prone, and increased pest and disease outbreaks, are also expected. Nature conservation and restoration efforts must incorporate climate scenarios to ensure that they are effective in the long term.

The proposed Soil Monitoring Law is expected to improve the detection of unhealthy soils across all land uses; it suggests that sustainable soil management practices would improve the functioning of soils where degraded. No matter what management practices are used, however, climate change negatively impacts soil health. Conversely, healthy soils play a pivotal role in addressing climate and environmental challenges through improved water retention, carbon sequestration and nutrient storage, and enhanced resilience against erosion and compaction. It is anticipated that reduced air pollution will further mitigate soil acidification.

Is Europe on track to meet key policy targets and objectives?

The EU's biodiversity and habitats across ecosystems are not yet being protected, conserved and enhanced in line with policy ambitions. The WFD required rivers, lakes, transitional waters and coastal waters to have a good ecological status by 2015, with a possible delay up to 2027 under certain circumstances. However, by 2021, only 37% of Europe's surface water bodies had a good or high ecological status[15].

The goal to achieve good environmental status for marine waters by 2020 has already been missed and is unlikely to be met by 2030. At the same time, the previous headline target of the EU biodiversity strategy for 2020 — to halt and reverse biodiversity loss — was not achieved[42]. The 8th Environmental Action Plan (EAP) and biodiversity strategy for 2030 also state the objective to halt and reverse biodiversity loss but the outlook for achieving these goals appears bleak.

It is currently not possible to assess progress towards the targets of the NRR, as the regulation has only recently entered into force and Member States are not required to submit their draft NRPs until September 2026 (Box 3.1).

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A recent Joint Research Centre (JRC) report assesses progress towards implementing the EU biodiversity strategy for 2030[43]. Indicators track 40% of the targets set out in the strategy; in general, they show progress in the right direction, though not in the case of indicators related to biodiversity state[43,44]. The JRC states that the pace of progress needs to accelerate massively to reach the 2030 targets. It highlights the need for environmental policies to be better implemented in order to 'meet the maximum of targets by 2030'[43].

In the areas of water scarcity, drought or flood risk management in Europe, there are currently no legally-binding targets. Europe's water management practices are poorly adapted for managing rapid and extensive change; this compromises water resilience.

Despite expected improvements, the EU is unlikely to achieve most of its pollution policy targets, facing ongoing challenges in the areas of water quality, nutrient losses, the release of microplastics, marine environmental status and the impacts of air pollution on ecosystems[28]. A good chemical status for freshwater ecosystems will not be achieved in line with the requirement set out in the water framework directive. The ZPAP target of a 50% reduction in nutrient loss to the environment by 2030 is likely unattainable due to persistent agricultural emissions. Equally, except in the case of beach litter, it may take a long time to achieve the good environmental status of European marine ecosystems required by the MSFD[45]. Despite anticipated further reductions, the target to reduce the extent of EU ecosystems threatened by air pollution by 25% is unlikely to be achieved.

Over the next 10-15 years, it will be crucial to accelerate the designation of protected areas since a substantial gap remains in terms of reaching the non-binding targets (of both the biodiversity strategy and the global biodiversity framework) for 2030 requiring 30% of land and marine territories to be protected. Although it is feasible to achieve this target— particularly given commitments by several countries — it will require significantly higher rates of designation compared to previous years.

There will need to be significant reductions in land conversion rates to meet the EU's non-binding target of 'no net land take by 2050' as outlined in the EU soil strategy for 2030. At present, reaching this target is uncertain but unlikely.

Given the considerable environmental legislation in place, it might seem counterintuitive that the state of biodiversity is poor, even accounting for implementation gaps. However, several factors explain this reality. First, there can be substantial delays before reduced pressures lead to measurable improvements in biodiversity and the condition of habitats. Second, despite recent reductions in some pressures — such as some sources of pollution — pressures remain significant overall. Third, evidence shows that while efforts to address biodiversity loss and ecosystem degradation have had a positive effect[46], the gains are not sufficient to meet the targets. Thus, without these ongoing efforts the state and outlook would be even worse than the current situation. Fourth, reversing biodiversity loss and ecosystem degradation requires not only the full implementation of existing environmental legislation but also the full integration of environmental concerns into the agriculture, energy, forestry, fisheries and transport sectors. It also requires a transformation of the food system, given that it significantly contributes to environmental pressures on biodiversity and ecosystems in the EU.

To conclude, the ambitious goals set for biodiversity and ecosystems have not yet translated into improvements in the state of biodiversity. It is essential that Member States fully and effectively implement environmental legislation aimed at protecting and restoring biodiversity and habitats across terrestrial, freshwater and marine ecosystems. This legislation includes the recent NRR, the nature directives, the WFD

and the MSFD. It is essential to fulfil the ambition in the NRR to implement restoration measures across at least 20% of the EU's land and sea areas by 2030.

Implementation gaps are widespread under the nature directives, the WFD and the MSFD[47]. A recent study found that delays in protecting 30% of the EU's land area costs between EUR 11 billion – 30 billion per year, while it is estimated that the total costs of not achieving 'good' status in WFD and MSFD is EUR 51.1 billion per year[48]. Some important barriers to the effectively implementing these directives include:

- insufficient financial and human resources for implementation;
- poor monitoring of progress;
- weak stakeholder involvement and low public support; and
- a lack of coherence between environmental objectives and sectoral policies, such as agriculture, forestry, fisheries, energy and urban development, where economic interests often override environmental concerns.

Given Europe's high economic dependence on biodiversity and well-functioning ecosystem services, a better quantification and assessment of escalating nature-related economic and financial risks is needed[49]. In that context, the wider application of natural capital accounting — a tool to measure the changes in the stock and condition of ecosystems — is important, to integrate the value of ecosystem services into policy and decision-making processes[50].

Without careful design, some financial and economic incentives in agriculture and fisheries can contribute to environmental pressures, potentially encouraging practices that may not align with biodiversity goals. According to the Organisation for Economic Co-operation and Development (OECD), it is essential to reform these incentives to ensure they support sustainable practices rather than unintentionally drive biodiversity loss[51].

3.1.4 Drivers and pressures

The five main pressures described in Section 3.1.2 stem from a range of underlying causes related to the primary production sectors: agriculture, forestry and fisheries/aquaculture, as well as from the energy and transport sectors. These economic sectors impact biodiversity and ecosystems through demand for their products and through direct environmental effects; they also play crucial roles in broader production and consumption systems, such as the food, energy and mobility systems.

Agriculture

The agricultural sector, the main food supplier, managed 38.8% of EU land as utilised agricultural land in 2022[52]. As well as providing the foundation for our food system, agriculture also supplies biomass for materials such as textiles and for energy. In addition, farmers manage natural resources, with an effect on habitats and species, and they also supply other services to society such as cultural and recreational services. Thus, it can be seen that agriculture plays a crucial role in contributing to food and nutrition security, human and ecosystem health, and sustainability goals such as social well-being[53].

In 2023, the EU's agricultural industry generated a gross value added of EUR 223.9 billion, contributing 1.3% of the EU's GDP[54]. As a leading global trader of

agri-food products, the EU saw a record net export of EUR 70.1 billion in 2023[55]. This is linked to the high prices of EU exports against low-priced imports.

The EU is heavily reliant on imports of products for animal feed, such as soybean and maize, products grown in tropical regions, such as cocoa, coffee and bananas, and commodities for secondary processing, such as palm oil, beet and cane sugar[56]. These imports drive the negative environmental footprint outside the EU such as deforestation[7]. Moreover, the EU is a net importer of mineral fertiliser, an essential input for agricultural productivity[57].

With a total workforce of 8.5 million people (4% of the EU workforce in 2022[58]), agriculture provides jobs in rural areas. However, employment in the sector has decreased dramatically over recent decades. Farmers are ageing and the number of farms, especially smaller ones, has been decreasing. Additionally, the sector is facing a major crisis in sourcing labour[59].

Agriculture is an ecosystem-based activity, as its production capacity depends on ecosystems and their functioning. Biodiversity loss and environmental degradation — such as the decrease in pollinators (partly due to pesticides) and soil degradation — raise concerns about its sustainability. The degradation stems predominantly from certain agricultural practices themselves. Intensification has created reliance on chemical inputs which can leak into the environment. These practices lead to habitat loss and poor conservation status for many semi-natural habitats in the EU. Thus, agriculture is one of the major drivers of soil degradation in Europe[60].

Data show that 89% of the agricultural area in Europe is likely to have its soil degraded by processes such as soil erosion and loss of soil organic carbon[60]. These processes cause soils to lose biodiversity and productivity. Moreover, some agricultural activities — especially intensive cropping systems with excessive fertilisation and intensive livestock breeding — release nutrients into water through surface runoff or direct discharge, harming rivers and coastal ecosystems[15].

Declining pollinator populations significantly threaten crop yields. The contribution of pollinators to the market value of agricultural crops is more than EUR 15 billion per year in the EU[61]. Moreover, climate change reduces EU production capacity. Adverse weather conditions like droughts have been negatively impacting crop yields. For example, green maize harvest per hectare dropped by 16% in 2022[62].

Despite the strong interrelationship between agricultural productivity and healthy ecosystems, several agricultural practices are still degrading the capacity of ecosystems to supply food in the future. Examples include monocropping, chemical plant protection and unsustainable soil management practices. In contrast, widespread practices such as extensive grazing help maintain natural and semi-natural habitats. Incorporating ecosystem restoration into agricultural practices offers opportunities to enhance food security and biodiversity[63].

Strategies outlined in the EGD's farm-to-fork initiative aim to increase organic farming to at least 25% of the EU's agricultural area by 2030; this would require the amount of organic land to be more than doubled[64]. The uptake of agroecological farming in the EU, a goal of the EU biodiversity strategy 2030, is still limited; a first estimate suggests that 0.6% of farms were using agroecological practices in 2015[65]. Achieving these targets requires systemic changes that redefine the nexus between food systems, human well-being and ecological health. The upcoming revision of the CAP represents a key opportunity to better align socio-economic, environmental and climate objectives.

Forestry

Forests in Europe are a vital component of the continent's environmental and economic landscape, providing a wide range of ecosystem services and supporting biodiversity. They cover 39% of EU land area[66], acting as significant carbon sinks and offering renewable resources such as wood, which is essential for both materials and energy production. Additionally, these forests are crucial for recreation and cultural services, enhancing the quality of life for many Europeans.

European forests face challenges despite an increase in forested areas. In 2022, 0.48 million people worked in forestry and logging in the EU-27[58], for a total value added of EUR 29.5 billion[67] (0.2% of GDP). In total, wood-based industries, which include the manufacturing of wood products, paper and paper products, as well as part of the printing and furniture industries, generate a gross value added of EUR 149 billion (1% of the EU GDP) and employ 2.8 million people[68].

The average condition of EU forests improved slightly from 2000 to 2018 but, in spite of this, one-third of the forest area was subject to declining conditions[69]. The status of many forest ecosystems is deteriorating due to factors such as droughts, fires, storms and pest infestations, which threaten forest health and resilience[70].

Forests are a pillar of climate change mitigation[71,72], sequestering and storing carbon in the biomass and soils. However, their carbon sink capacity has decreased in the last decade due to a combination of interrelated factors such as forest ageing, droughts, pests, climate change and increased harvesting[73] (see also Section 3.2).

Wood products, especially long-lived ones, can help mitigate climate change by storing carbon. Some provide an alternative to greenhouse gas intensive materials such as concrete[74]. However, an increase in the demand for wood products and for bioenergy puts further pressure on forests; this can have negative effects on their role as carbon sinks and on biodiversity[75]. For example, without implementing adequate sustainability criteria, an increased demand for biomass for energy can encourage land management practices that maximise biomass production despite these efficiencies being detrimental to biodiversity[76].

In Europe, most forests have been actively managed. Primary or old-growth forests only cover less than 1% of EU land[77]. Intensive forest management has had a critical influence on the status of ecosystems resulting in, for example, reduced numbers of species and deadwood[78], which are critical not only to biodiversity but also to resilience to climate change. Sustainable forest management practices, including the adoption of 'close to nature' forestry, which aligns with the European Commission's (EC) guidelines, are key to maintaining biodiversity and enhancing forest resilience.

Forests are also a cornerstone of the European bioeconomy, which provided employment for more than 17 million Europeans in 2021[79] and forms the basis of value chains that support rural economies[66].

Fisheries and aquaculture

Europe's fisheries and aquaculture sectors play a crucial role in food security; however, they both face significant environmental and sustainability challenges. Fisheries rely on healthy marine and freshwater ecosystems, yet overfishing — along with pollution, climate change and invasive species — is a major contributor to biodiversity loss in Europe's seas, lakes and rivers[80]. In 2022, fisheries and aquaculture (including marine and freshwater activities) employed 158,000 people[79], producing a total value added of

EUR 6.4 billion[67]. Like other primary sectors, fisheries and aquaculture supply essential inputs for various industries.

Despite some success in reducing fishing pressure on certain fish populations, only 28% of assessed stocks are sustainably fished and in good biological condition, with clear regional disparities: 41% of stocks in the North-east Atlantic and Baltic Seas are sustainably fished, compared to 9% in the Mediterranean and Black Seas[22].

Declining fish populations and shifts in species distribution[28] can lead to increased fishing effort, with associated higher operational costs and degradation of marine ecosystems. Production is dominated by a large-scale, industrial fleet which often uses more environmentally-harmful fishing methods, such as bottom trawling and dredging; these are more energy-intensive and less selective, contributing to the bycatch of sensitive species and habitat loss, and also contributing less to coastal employment[81]. Shifting to low-impact fisheries would lessen these impacts while supporting coastal communities and the EU's aim of achieving a climate-neutral sector by 2050[3,8].

Certain forms of aquaculture offer a potential solution to alleviate pressure on wild fish stocks, provide alternative sources of income and enhance the EU's food security. This is particularly the case for low-trophic species like shellfish and seaweed, which not only have lower environmental impacts but can also provide ecosystem benefits by absorbing carbon and nutrients, potentially aiding in carbon dioxide (CO_2) sequestration and mitigating eutrophication. Yet, the production of high-trophic species, such as carnivorous finfish, is increasing in Europe, largely due to its higher market value[82]. However, this type of aquaculture comes with high environmental costs, particularly given the demand for fishmeal and fish oil as ingredients for feed, the related pressures on water use and the resulting effluents[83,84,85].

Despite its potential, EU aquaculture production is lower than many other places in the world. In the meantime, the EU is heavily reliant on imports to meet its growing demand for aquatic food products. With the average EU resident consuming 24kg of seafood annually, the region imports over 70% of its fish and shellfish products[5]. This dependence on imported seafood products not only puts pressure on global fish stocks and marine ecosystems outside Europe but also highlights the need to foster more sustainable and responsible consumption patterns within Europe.

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3.2 Climate change mitigation and adaptation

3.2.1 Introduction

What is covered?

This section covers both climate change mitigation — including efforts to reduce greenhouse gas (GHG) emissions towards climate neutrality — as well as climate change adaptation, and efforts to reduce climate risks in Europe.

Why is it important?

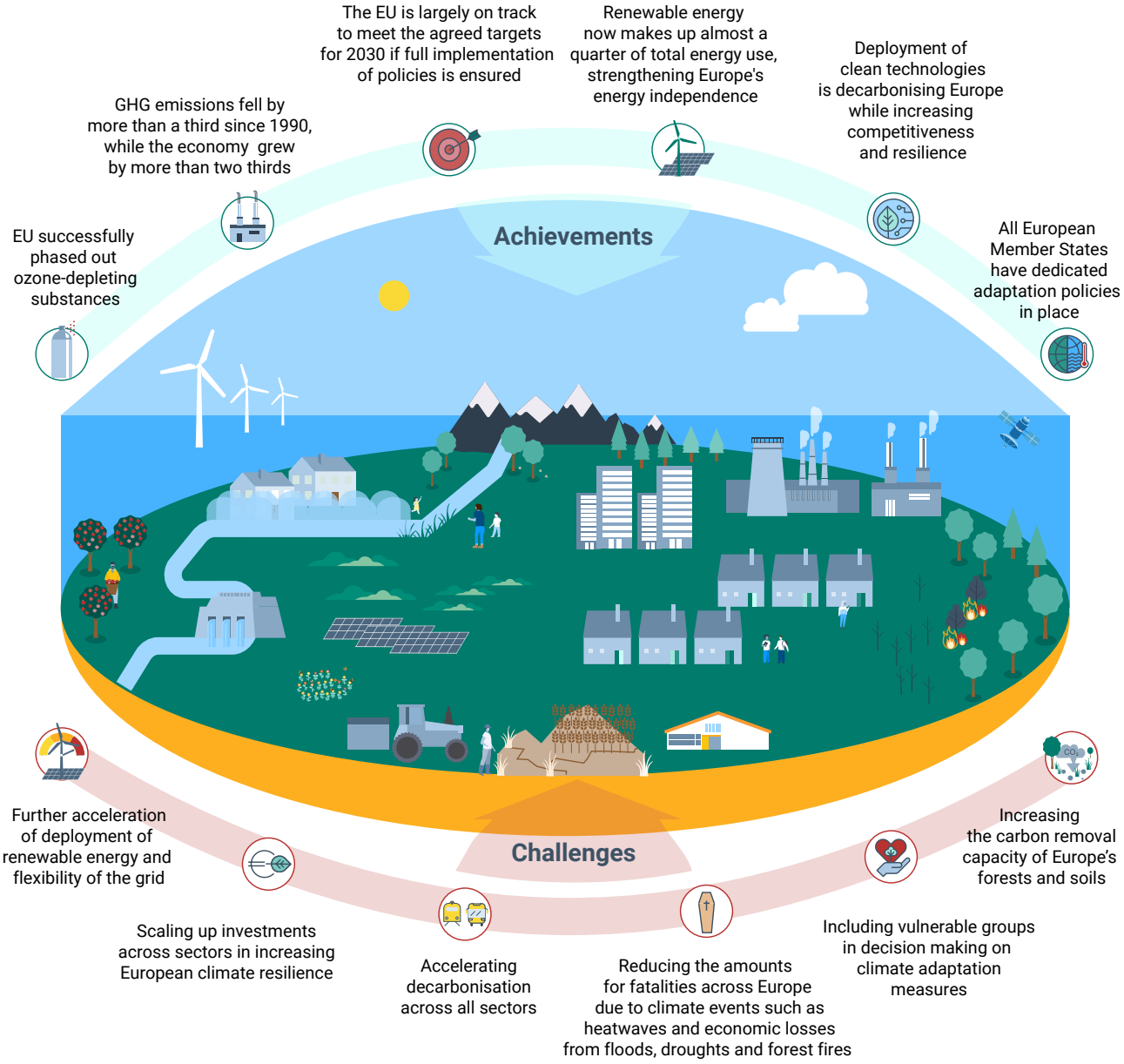
Human-induced climate change is happening now and before our eyes. In 2024, Earth exceeded the 1.5°C threshold above pre-industrial level for the first time[86]. This is in spite of the fact that the Paris Agreement had set a binding target (calculated over a longer period) to limit global warming to this threshold. Further, Europe is the fastest-warming continent, warming twice as fast as the global average. As a result, many of the extreme weather events in Europe, except those related to snow and ice, have become more frequent and/or intense as a result of anthropogenic climate change[87].

Weather- and climate-related extremes caused economic losses of assets estimated at EUR_{2023} 738 billion between 1980 and 2023 in the EU, with over EUR_{2023} 162 billion (22%) of those losses occurring between 2021 and 2023[88]. Downpours and other precipitation extremes are increasing in severity; in recent years, various regions have seen catastrophic floods. In 2024, floods in Slovenia resulted in a 16% loss in GDP, while floods in Valencia in 2024 caused over 250 fatalities.

At the same time, southern Europe is plagued by water scarcity and wildfires and can expect considerable declines in overall rainfall and more severe droughts going forward (Figure 3.4). Extreme heat, once rare, is becoming more frequent, with deadly consequences: over 70,000 people in Europe are estimated to have died from heat in 2022[89], followed by 48,000 in 2023[90].

Overall, 240,000 fatalities have been caused by weather- and climate-related extreme events between 1980 and 2023 in the EU-27[88]. Climate-related extreme events, combined with environmental and social risk drivers, pose major challenges throughout Europe[24]. Specifically, they compromise food and water security, energy security and financial stability; additionally, they place the health of the general population and outdoor workers at risk. In turn, this affects social cohesion and stability. At the same time, climate change impacts terrestrial, freshwater and marine ecosystems. Many of these risks have already reached critical levels and could become catastrophic without urgent and decisive action. It is crucial to enhance our resilience and preparedness, as Europe is not currently well-positioned to cope with accelerating climate change[24].

Figure 3.4 **Benefits of a stable climate/risks of climate change**



Source: EEA, 2025.

What is the EU doing?

The EU is addressing climate risks through both climate change mitigation and adaptation strategies. The EU's legal framework, established under the European Climate Law[91], sets a binding target to achieve climate neutrality by 2050 at the latest, with the interim target of reducing net GHG emissions by at least 55% by 2030 compared to 1990 levels. These targets are reinforced by a robust policy and legal framework, including binding GHG emission reduction and removal targets for Member States (with the effort sharing regulation (ESR) and land use, land use change and forestry (LULUCF) regulation), the European-wide emissions trading system (ETS), a detailed climate and energy governance framework and a comprehensive set of supplementary legislation addressing diverse sectors, many of which are established as part of the Fit for 55 package.

At the same time, the European Climate Law acknowledges that, while critical, mitigation alone is not enough. Adaptation is recognised as a key component of Europe's long-term global response to climate change and requires Member States and the EU to enhance their adaptive capacity, strengthen their resilience and reduce their vulnerability to climate change. The EC's 2024 communication on managing climate risks sets out a vision for stepping up action to improve our societal and economic resilience and preparedness in the face of climatic conditions that have already changed[92]. The EU Preparedness Union Strategy aims to prevent and react to emerging threats and crises, including climate change among the growing security challenges. Further, the EU Climate Adaptation Plan is currently in preparation, due to be published in late 2026. This plan is expected to outline specific measures to prepare for and address the already inevitable impacts of climate change.

The global dimension

Climate change is a global problem, requiring global action on both mitigation and adaptation. Europe accounts for 6% of current global emissions and, in contrast to the declining GHG emissions in the EU, global GHG emissions are still on the rise, increasing by more than 60% since 1990[93]. Within the framework of the Paris Agreement, the parties to the UNFCCC have set the target of limiting the global temperature rise this century to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. As global emissions continue to increase despite efforts in Europe, the global community must step up its climate action to reduce GHG emissions.

The Paris Agreement also established the global goal of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response. To guide the achievement of the global goal, a framework of targets was initiated by the UNFCCC parties (the United Arab Emirates (UAE) Framework for Global Climate Resilience) and a 2-year UAE—Belém work programme on the development of indicators to measure the progress achieved towards those targets has been ongoing since 2023[94].

What is the current state at the European level?

Table 3.2 compiles past trend assessments over the last 10 to 15 years, outlooks 10 to 15 years ahead, and assessments of the prospects of meeting 2030 and 2050 EU policy targets (where in place) from the nine thematic briefings related to climate change mitigation and adaptation. Details on the assessments, as well as on cross-cutting drivers and pressures, are provided in Sections 3.2.2 to 3.2.4.

Table 3.2 Overview of assessment results on climate change

Briefing	Greenhouse gas emissions (net)	Trends in the mobility system	Trends in the energy system	Carbon dioxide removal from the atmosphere	Ozone-depleting substances and fluorinated greenhouse gases	Climate risks to the economy	Climate risks to society	Climate action financing	Governance of climate change mitigation and adaptation
Past trends (10-15 years)									
Outlook (10-15 years)									
Prospects of meeting EU policy targets for 2030									
Prospects of meeting EU policy targets for 2050									

Improving trends (are expected to) dominate/largely on track to meet policy targets

Trends (are expected to) show a mixed picture/partially on track to meet targets/highly uncertain

Deteriorating trends (are expected to) dominate/Largely not on track to meet policy targets

No specific policy targets

Source: Climate change briefings of *Europe's environment 2025*.

3.2.2 Past trends

Progress in climate change mitigation: achievements and challenges

The EU has demonstrated that it is possible to cut emissions significantly while maintaining economic growth. In 2023, EU total net GHG emissions decreased by more than 9% over the course of one year, resulting in a domestic emission level 37% lower than the 1990 baseline. Adding the emissions from international aviation and international navigation, which are also included in the 2030 target, brings the total net reduction to 35.5%. The emission reduction in 2023 represents the largest relative emission reduction per year of the past several decades, excluding the COVID-impacted year of 2020[95]. As such, it confirms the accelerated emission reductions witnessed in recent years, supported by a robust climate governance framework, as also illustrated by the positive (green) assessments in Table 3.2.

Since 1990, Europe's declining use of fossil fuels — coal in particular — has been the largest driver of GHG emission reductions. The accelerating decarbonisation of the European economy has been possible due to developments in the energy system (also green for past trends in Table 3.2), such as the rapid expansion of renewable energy and increased energy efficiency. The share of renewable energy has grown from 10.2% in 2005 to 24.5% of the EU's gross final energy consumption by 2023[96]. Considerable variations exist across countries but the number of countries with shares of renewable energy of over 40% has increased from five to 10 since 2019 (additional details in the country profiles of *Europe's environment 2025*). Further, the EU has managed to reduce its energy use: primary energy consumption has fallen by 19.2% since 2005, while final energy consumption saw a 10.1% reduction in the same timeframe[97].

In contrast, developments in the area of mobility have been less positive. While GHG emissions from all domestic transport types peaked in 2007, they have only showed a modest decline since then. As of 2023 this resulted in an emission level 18% higher than in 1990; at the same time, however, this was a 6% reduction compared with 2005[98]. This trend was mainly driven by increases in passenger and freight transport activities of 25% and 45% respectively since the early 1990s; these have offset improvements in energy efficiency and technology. That means the relative share of GHG emissions from transport in the EU has been growing.

GHG emissions from agriculture fell by 25% from 1990 to 2023, with significant reductions up to 2005 and relatively little progress since (EEA, forthcoming 2025). Here, GHG emissions from agriculture refer to methane and nitrous oxide only; other agricultural emissions are included in the energy sector and in the LULUCF sector. At the same time, in the LULUCF sector, the contribution of Europe's terrestrial ecosystems to climate mitigation acting as a net carbon sink shows a declining trend. Between 2014 and 2023, the EU's average net annual carbon sink was 30% smaller compared to the decade before, largely due to a combination of interrelated factors in forest land. Regarding trends in GHG emissions and emission from the LULUCF sector at national level, see country profiles of *Europe's environment 2025*. Further details on sector-/systems-specific emissions are provided in Section 3.2.4.

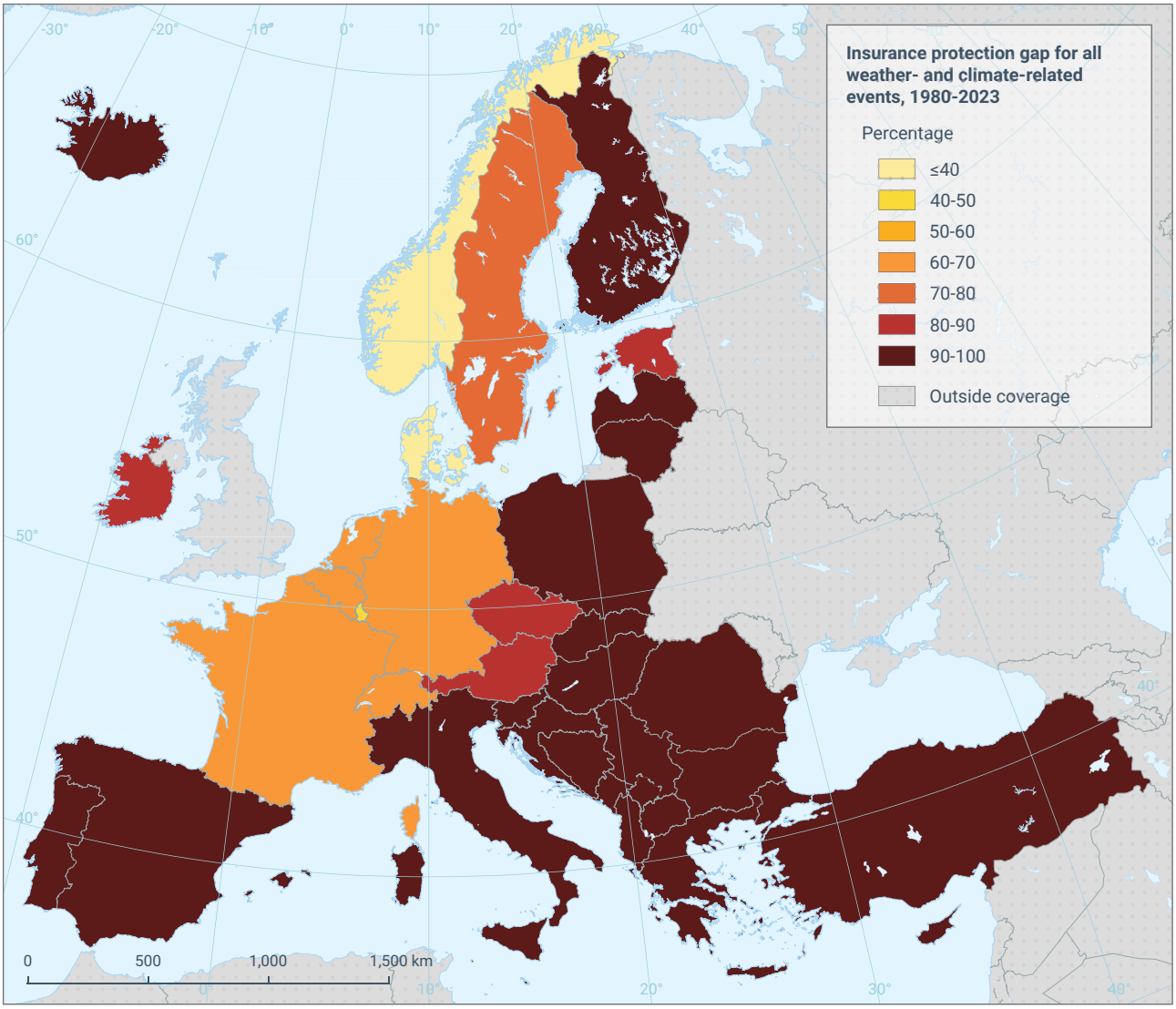
Developments related to ozone-depleting substances (ODS) covered by the Montreal Protocol are again positive. Their consumption has declined in the EU (and worldwide) by about 99% from 1986 to 2023. The remaining 1% reflects some industrial processes, firefighting, laboratory and analytical uses where alternatives are not yet widely available. The successful phase-out of ODS has led to the introduction of hydrofluorocarbons (HFCs), which are themselves potent GHGs and the primary emission source for fluorinated greenhouse gases (F-gases). Phase-out of HFCs in the EU started in 2015 and is on track.

Increasing climate change risks and the need for climate adaptation

While climate change mitigation efforts are essential, the increasing frequency and magnitude of climate-related disasters underscores the urgent need to adapt European society and the economy (Table 3.2). For example, the average annual economic losses associated with weather- and climate-related extremes in the EU were around EUR_{2023} 8.5 billion from 1980 to 1989, EUR_{2023} 14.0 billion in from 1990 to 1999, EUR_{2023} 15.8 billion in from 2000 to 2009, EUR_{2023} 17.8 billion from 2010 to 2019 and EUR_{2023} 44.5 billion for the period 2020-2023[88] (for details see briefing 'Climate risks to the economy'). That means, the average annual economic losses associated with weather- and climate-related extremes in the period 2020 to 2023 were 2.5 times as high as in the preceding decade from 2010 to 2019.

The insurance protection gap across Europe is substantial, with most countries reporting over 50% of losses as uninsured (Map 3.1). The insurance protection gap has widened over time, as uninsured losses have grown at a faster rate than insured losses[99]. The Lancet Countdown in Europe estimated that heat-related deaths increased in 94% of European regions between the periods 2003 to 2012 and 2013 to 2022. The overall mean increase was estimated to be 17.2 deaths per 100,000 inhabitants[100]. The average losses associated with droughts are valued at EUR 9 billion/year[92].

Map 3.1 **Insurance protection gap for all weather- and climate-related events, 1980-2023**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Source: EEA[99].

Most of the climate-related hazards across Europe are increasing[24]. The characteristics of our society — with an ageing population, a high prevalence of chronic diseases, and persisting inequalities between the European regions and between urban and rural areas — make Europe particularly vulnerable to climate risks. Similarly, our economy and its dependence on global supply chains are vulnerable to these risks. Several climate risks have already reached critical levels, in particular in southern Europe. At the same time, 21 of the 36 major climate risks identified by the European Climate Risk Assessment require more action. The policy readiness to deal with these risks varies depending on the sector/system and type of risk. In most cases, however, there is room for improvement[24].

Currently, efforts to manage climate risks through policy, governance and financing are still lagging yet accelerating in relation to the increasing severity of risks. In this

context, the EU has made considerable progress in understanding the climate risks it is facing and preparing for them.

The EU Preparedness Union Strategy aims at enhanced climate adaptation and securing the availability of critical natural resources such as water. This is to be achieved through an integrated approach that focusses on multiple (climatic and non-climatic) hazards simultaneously, brings together all relevant actors across all levels of government (local, regional, national, and EU), and brings together citizens, local communities, civil society, businesses, social partners and academic communities.

National climate risk assessments are increasingly used to inform the development of adaptation policy(24). All EU Member States have a national adaptation policy in place; many also have regional or sectoral adaptation policies or action plans(101). In 2024, 24 out of the 38 EEA member countries had legislative provisions for adaptation; 18 countries had a standalone climate law, with an adaptation component(102). The number of sub-regional authorities with adaptation plans in place has also increased substantially over the past decade. For example, since April 2025, over 5,956 local authorities have been committed to action on adaptation under the EU Covenant of Mayors for Climate & Energy initiative(103).

EU legislation, such as the floods directive or the water reuse regulation, have ensured that some of the risks under climate change, such as floods and droughts, are addressed consistently across countries. At the same time, looking at other increasingly pressing risks, only 21 out of the 38 EEA member countries have heat-health action plans in place setting out governance protocols and procedures to address the risks of extreme temperatures to human lives(104) and drought management is regulated by legislation in only 19 EU Member States(105).

Thus, societal preparedness for weather extremes and other climate impacts is still low; whilst appropriate governance structures and policies exist (Table 3.2), actual implementation of measures is lagging substantially behind the rapidly increasing risk levels(24). The extent to which we can avoid damages will largely depend on how quickly we can reduce global GHG emissions, and how quickly and effectively we can prepare our societies and adapt to the unavoidable impacts of climate change(24).

In summary, to address the climate crisis effectively, Europe must accelerate both its mitigation and adaptation efforts. This requires urgent and decisive action at all levels — global, national and local — to reduce vulnerabilities, enhance resilience and facilitate transition to a sustainable, low-carbon economy.

3.2.3 Outlook and prospects for meeting policy targets

As the EU progresses towards climate neutrality, significant strides have been made in both mitigation and adaptation. However, challenges remain: the pace and scale of action need to accelerate to meet key targets.

Climate change mitigation

The accelerated emission reductions witnessed over the past decades are expected to continue in the years ahead, and in their regular progress reporting, Member States are demonstrating growing ambition levels. Collectively, Member States project that their current and planned additional policies and measures will deliver net GHG emission reductions converging towards the 2030 target of net 55 %.

Member States have finalised their updated National Energy and Climate Plans (NECPs) and integrated further Fit for 55 legislation. Together, they demonstrate how Member States collectively anticipate approaching the 2030 climate target of a net 55% reduction. In the crucial years remaining to 2030, implementation of an array of EU and national policies and measures will be critical. This will require significant investment, with a need for public as well as private funding to be scaled up.

Beyond 2030, the European Climate Law requires that a new emission reduction target is set for 2040 to put the EU on course for climate neutrality by 2050. The European Scientific Advisory Board on Climate Change (ESABCC) recommends EU emission reductions of 90-95% by 2040, relative to 1990 levels, in a science-based assessment that takes into account both fairness and feasibility(106).

With its proposed amendment to the European Climate Law in July 2025, the European Commission (EC) echoed this scientific recommendation, proposing an additional interim target of reducing the EU's net GHG emissions by 90% by 2040 relative to 1990, based on an impact assessment(107).

Reducing net emissions by 90% by 2040 would put the EU on course towards climate neutrality by 2050. This would ensure predictability for citizens, businesses and investors by making sure that resources invested now and in the coming decades are compatible with the EU's pathway to climate neutrality, avoiding wasted investments in the fossil fuel economy. At the same time, it would boost the competitiveness of Europe's businesses, create stable and future-proof jobs, enable the EU to lead the way in developing the clean technology markets of the future and make Europe more resilient, strengthening its strategic autonomy. To reach this 90% target by 2040, the EGD must be fully implemented, sector-specific targets must be reached and new, extended and expanded policies must be developed.

The EU's energy sector will play a pivotal role in meeting climate goals. The revised renewable energy directive sets a binding target for renewable energy to account for at least 42.5% of the EU's energy mix by 2030, with a further aim of reaching 45%. Simultaneously, the recast energy efficiency directive aims to reduce EU energy consumption by *circa* 12% by 2030, compared with business as usual, complemented by revised EU rules for gas and electricity markets, the ecodesign for sustainable products regulation, and the energy performance of buildings directive. The recent EEA report on the transformation of the EU energy system(108) provides a detailed assessment of the different levers in the energy transition, including renewables, electrification and flexibility.

From a country perspective, the NECPs are essential strategic planning tools, playing a central role in achieving climate mitigation targets, increasing the share of renewables in the national energy mix, steering energy efficiency measures (e.g. in buildings, industries and transportation) and identifying support mechanisms (e.g. financial incentives, grants and subsidies) to support renewable energy projects and improvements in energy efficiency. In its latest 2025 assessment of the NECPs, the EC found that the collective actions and ambitions of the EU countries are moving closer to achieving the EU's headline climate and energy targets(109). Nonetheless, in the areas of renewable energy and energy efficiency the total of the national contributions in the NECPs still reveal an ambition gap compared with the EU 2030 targets, indicating the need for further efforts. At the same time, additional measures can be taken to make sure NECPs lever progress on carbon-neutral solutions across the EU economy, including by making progress in crucial areas such as the circular economy and accelerating the phase-out of fossil fuel subsidies.

Binding emission reduction targets for 2030 also exist for buildings and these need to be implemented. The EGD and the Renovation Wave initiative place a strong emphasis

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on reductions in GHG emissions and energy use from buildings. Additionally, a revised energy performance of buildings directive was adopted in 2024.

For transport, new CO_2 standards ensure that all new cars and vans registered in Europe will be zero-emission by 2035. As an intermediate step towards zero emissions, average emissions from new cars and new vans will have to come down by 55% and 50% respectively by 2030. Furthermore, from 2027, fuels used in road transport as well as buildings will be covered by the EU carbon market in the form of a new Emission Trading System, referred to as ETS 2. While this will seek to reduce GHG emissions from road transport, it is also expected to stimulate cleaner fuel use. To support a fair transition towards climate neutrality the Social Climate Fund (SCF) will be established from 2026 onwards. Its purpose is to help Member States to alleviate the social and economic impacts of this new ETS 2 system by financing investments in energy efficiency and zero-emission solutions for the most vulnerable groups in society.

The LULUCF regulation — revised in 2023 — establishes a collective EU removals target of 310 million tonnes of carbon dioxide equivalent ($MtCO_2e$) by 2030. Targets for Member States will require an additional removal of 42 $MtCO_2e$ by 2030, compared to the 2016-2018 average. However, the carbon removal capacity of the LULUCF sector has decreased over the last decade, and Member States' projections suggest that the EU is not on track to meet its target for 2030. Instead of an increase in removals compared to the 2016-2018 average levels, these projections indicate a reduction in removals.

There are no explicit 2030 financial targets for climate action investment in Europe. However, countries are required to commit 100% of their revenues from auctioning ETS credits on the EU carbon market to climate- and energy-related investments. Further, 30% of the EU budget in 2021-2027, totalling EUR 2.018 trillion, is committed to climate change, with a number of dedicated funding sources such as the Social Climate Fund (SCF), Just Transition Fund (JTF), Recovery and Resilience Facility (RRF) and others. Additionally, the taxonomy regulation defines economic activities that contribute to both objectives, for use by financial undertakings to allow them to be more transparent in their investment portfolios. Looking ahead, a proposal for the next EU budget period — the multiannual financial framework 2028 to 2034 — has recently been presented by the EC, with decarbonisation and clean technology as key components.

Climate change risks and adaptation

Whilst the governance of climate change (the distribution of responsibilities and policy development at the EU, national and subnational levels) offers reasons for optimism for future resilience to the climate crisis, the pace and scale of adaptation actions needs to increase. If Europe does not implement the solutions identified, it is still not adequately prepared to address the risks posed by climate change and the societal and economic losses will remain or increase in the near future. Climate change is projected to increase economic costs across Europe significantly, driven by more frequent and intense extremes and slow-onset impacts, with some regions facing particularly high risks due to cascading and compounding effects[24]. There is an urgent need to mainstream and upscale climate adaptation across sectors and governance levels to address the growing risks from extreme heat, drought, wildfires and flooding[24].

The current lack of measurable adaptation policy targets (cf. no targets under climate risks to the economy and society in Table 3.2) and associated indicators makes it difficult to assess the progress made and the future prospects. The

ongoing development of the EU's Climate Adaptation Plan offers hope for a more legislative- and target-led approach to adaptation in the future.

The 2021 EU's Adaptation Strategy, promoting smarter, faster and more systemic adaptation, has called for the use of nature-based solutions for climate adaptation and disaster risk reduction. Applied at scale, such solutions could also enhance biodiversity in urban and rural landscapes, with such measures foreseen under most urban adaptation plans in Europe[103]. The EU's Adaptation Strategy also promotes a wider use of drought management plans, measures to increase the water retention capacity of soils and safe water reuse.

In this context, the water reuse regulation, applied from 2023, can contribute to adaptations designed to cope with more frequent and severe droughts. Expanding and replicating local initiatives, in combination with infrastructural and institutional measures, will be necessary to build resilience across Europe[110]. The 2024 EC communication on managing climate risks firmly states that the ultimate goal of adaptation actions is to protect people and prosperity.

Yet other aspects emphasised in the EU's Adaptation Strategy, the 2024 EC communication on managing climate risks and the 2025 EU Preparedness Union Strategy — such as the focus on vulnerable groups and achieving just resilience essential for equitable management of climate risks to society — are less frequently found in adaptation practices. Climate adaptation measures which are currently in place do not benefit everyone in society to the same extent. If equity is not adequately taken into consideration in adaptation, existing inequalities may be reinforced or new inequalities may arise.

Although EU and national climate policies draw attention to vulnerable groups and emphasise the need for equitable adaptation solutions, the practical implementation of such solutions remains scarce — for example, the insurance protection gap remains an issue. Ensuring that no one is left behind requires a focus on justice at all stages of adaptation planning, implementation and monitoring, and also requires the meaningful engagement of vulnerable groups[111]. The forthcoming European climate adaptation plan is an opportunity to embed fairness in societal preparedness for climate change.

Adaptation policies and actions are usually designed for the long term and some measures have long lead times. Urgent action is needed now to prevent rigid choices that are not fit for the future in a changing climate, for example, in land-use planning and long-lived infrastructure. The EU must prevent itself from being locked into maladaptive pathways and must avoid potentially catastrophic risks[24]. As adaptation policies can both support and conflict with other environmental, social and economic policy objectives, an integrated approach considering multiple policy objectives is essential in order to ensure efficient adaptation[24].

Implementing other legislation beyond the climate adaptation realm will also contribute to greater societal preparedness. For example, identifying the assets at risk from climate-driven extreme weather events and developing resilience strategies under the critical entities resilience directive is expected to increase the resilience of European society to climate change. Other adaptation efforts play out in areas for which the primary responsibility rests with EU Member States, such as healthcare, infrastructure and spatial planning. Thus, public authorities at the national, regional and city levels are crucial in delivering adaptation and success hinges on national prioritisation and funding for those authorities.

At the national level, the ongoing progress from climate adaptation strategies to climate adaptation plans, including sectoral and subnational ones, means that

the work on adaptation is becoming more concrete every year. Climate laws are increasingly emerging as instruments to give greater legal power to adaptation policies. Subnational adaptation policymaking is progressing in all countries: in some this is driven by legal requirements for municipalities and in others it is due to voluntary and bottom-up initiatives. However, governance-related challenges are a persistent barrier to the implementation of adaptation actions in many countries, even where well-developed governance frameworks are in place. These challenges include difficulties in coordination due to financial, technical and human limitations[112].

Another key barrier to the development and implementation of further adaptation solutions relates to difficulty comparing adaptation versus inaction scenarios. EU efforts in Destination Earth (a highly-accurate digital model of the Earth — a digital twin — to model, monitor and simulate natural phenomena, hazards and the related human activities) offers a potential avenue for modelling the impacts of future solutions.

Considering strained national budgets will remain, EU funds will continue to play a major role in financing adaptation action for most Member States. Yet, whilst the EU budget is on track to exceed its climate change mitigation and adaptation spending target of 30% between 2021 and 2027, the money invested in adaptation is not earmarked as such, resulting in an information gap on the actual spending. Some countries also report dedicated national adaptation funds to finance the implementation of national or sectoral adaptation actions. However, it is very unclear to what extent the actions planned in the national adaptation plans have been implemented, as countries are obliged to report on policies rather than measures.

Meeting climate change mitigation and adaptation targets requires a concerted effort across all levels of governance. The EU's approach to climate action — from its ambitious emission reduction targets to its increasing focus on climate resilience — provides a strong framework for the future. However, achieving these goals will require not only continued investment but also a commitment to equity, fairness and integration across sectors. As the EU works towards a carbon-neutral and climate-resilient future, the need for urgent and coordinated action has never been more critical.

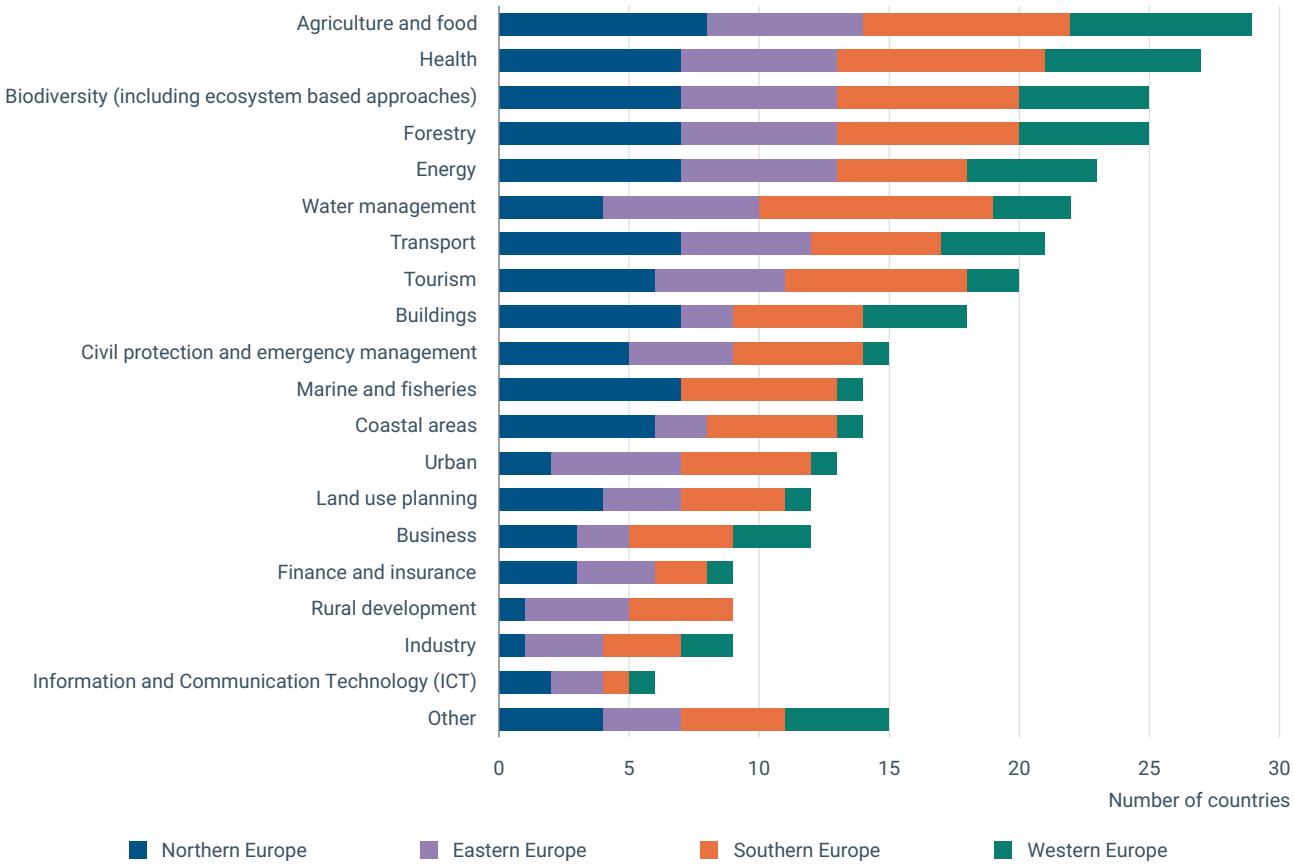
3.2.4 Drivers and pressures

To address both climate adaptation and climate mitigation, it is essential to understand how various sectors are not only impacted by climate change but also contribute to GHG emissions. Climate change affects key economic sectors in Europe — agriculture/food, forestry, energy, the built environment and transport/mobility — while these same sectors also drive emissions that contribute to the climate crisis. In other words, the effects of climate change mitigation and adaptation are interconnected and have a dual impact on the different sectors in society.

Climate-related risks to sectors

The EU Member States and Iceland, Switzerland and Türkiye most often report on agriculture, health biodiversity, and forestry as the key sectors affected by climate change (Figure 3.5).

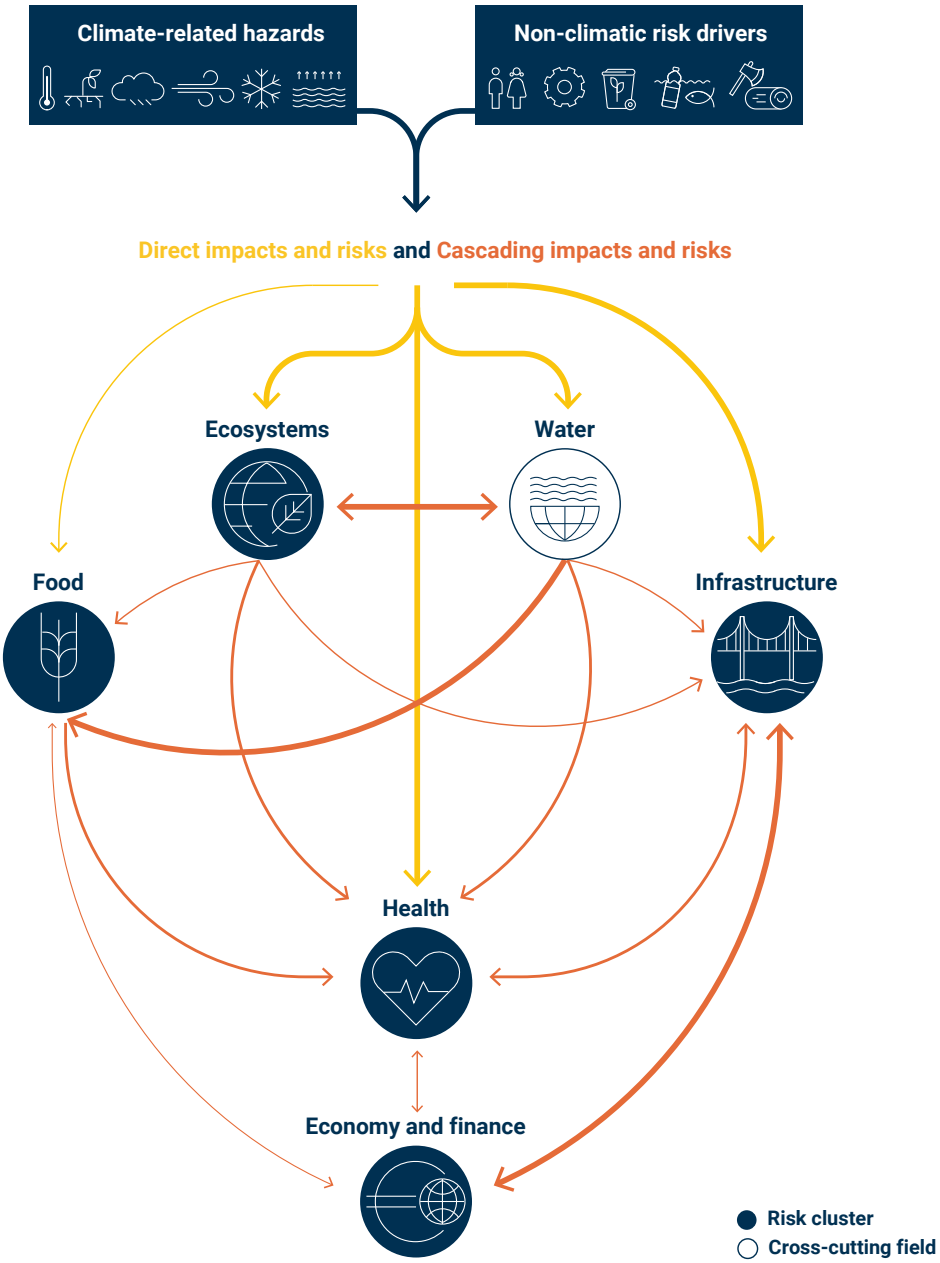
Figure 3.5 Sectors affected by climate change by geographical area in 2025



Source: Updated from EEA[112].

Climate-related risks are interconnected, with cascading effects from one system or place to another, including from outside regions to Europe. Cascading climate risks can lead to system-wide challenges affecting whole societies, with vulnerable groups particularly affected (Figure 3.6). In addition, climate tipping points, critical thresholds in the Earth's climate system that, once crossed, can trigger rapid, abrupt, and often irreversible changes to large-scale systems like ice sheets, rainforests, and oceans. Recent research suggests that multiple tipping points could be crossed if global warming exceeds 1.5°C above pre-industrial levels[27], which could lead to dramatic changes in climate-related risks in Europe. Such risks are not taken into account in the assessment of risks to sectors in this report.

Figure 3.6 **Links between risk drivers and clusters of climate risks**



Note: The figure, originating from the European Climate Risk Assessment, illustrates the interconnections and risk transmission pathways from key climate-related hazards (e.g. heatwaves, prolonged droughts and floods) and selected non-climatic risk drivers (e.g. ecosystem fragmentation, pollution, unsustainable agricultural practices and water management, land use and settlement patterns and social inequalities) via the main climate impacts for five clusters of interrelated risks assessed in EUCRA and the cross-cutting field 'Water'.

Source: EEA[24].

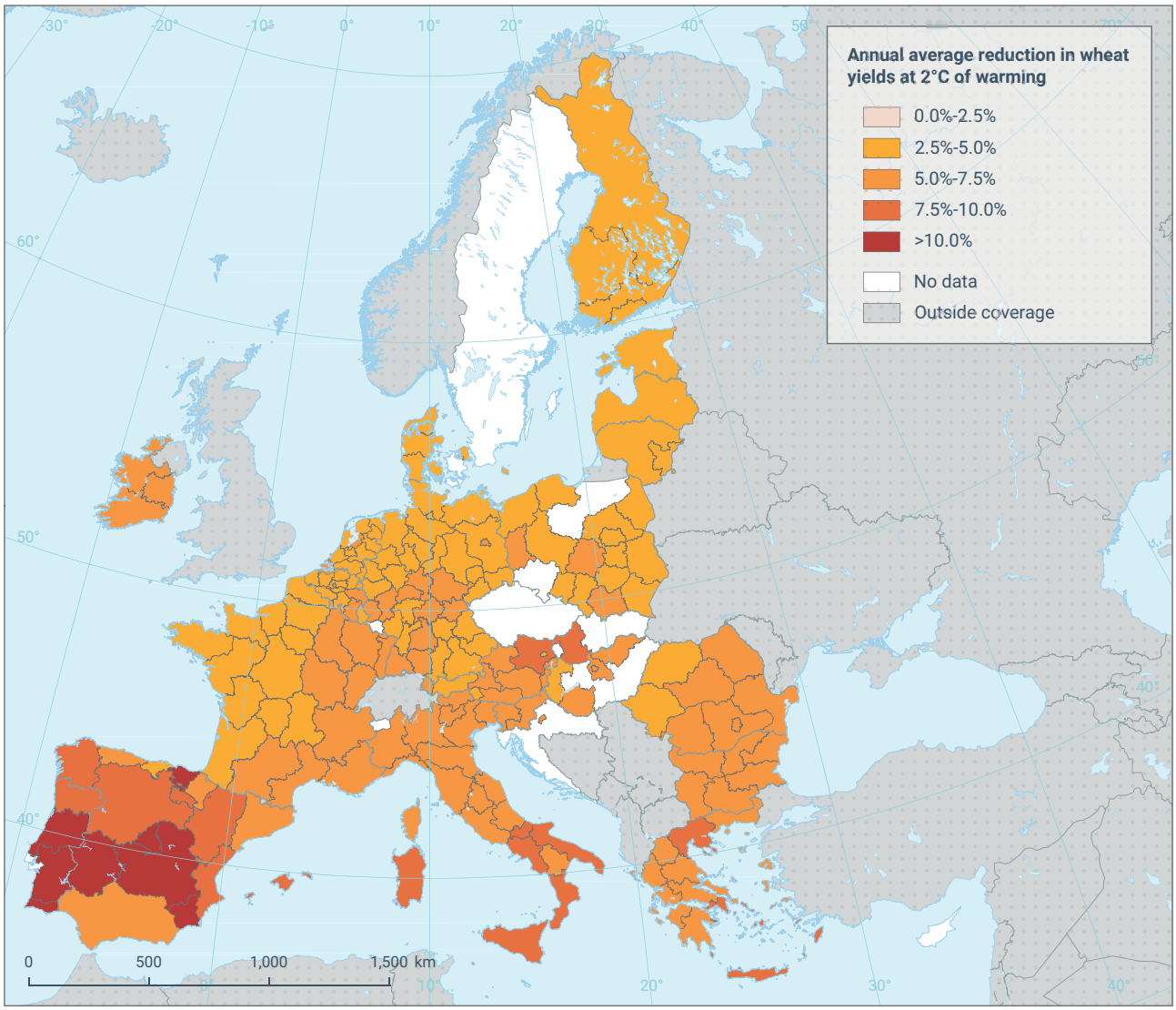
Agriculture/food

Key climate risks to European food production are reductions in crop yields from changing growing conditions and extreme weather events, particularly in southern Europe. Food production is at particular risk from reduced water availability and quality[24]. Recent estimates suggest an annual average loss to yields in the EU-27 of EUR 28.3 billion due to climatic factors, about 6% of annual crop and livestock production in the EU. Over 50% of these losses are caused by droughts. The countries with highest annual losses are Germany, France, Italy and Spain, each estimated to lose EUR 2-3 billion on average every year[113].

In 2022, most of Europe suffered from severe drought in the spring and summer, and the agricultural losses were considerable. In the case of maize, there was a yield loss of 50% or even 60% in Bulgaria, Romania and Hungary. Losses in production of cropland farming associated with extremely high market prices reached 1-2% of GDP in some countries that year[114]. Between 2000 and 2023, on average over 69,000 square kilometres (km²) of cropland were affected by drought each year across the EU-27[115]. In the record-breaking year of 2022, over 313,000km² of cropland were affected by drought[116].

Looking forward, agricultural yield losses due to climate change are expected to increase across almost the whole of Europe. At 1.5°C of warming, it is estimated that average annual crop yield loss in the EU will be 5%, rising to nearly 6% if temperatures rise by 3°C. Maize and wheat will be hardest hit, with annual losses of over 5% if temperatures stay below 1.5°C, rising to 6.1% at 3°C of warming (EEA, forthcoming 2025). Map 3.2 presents the average annual percentage reduction in wheat yield by region at 2°C of warming. Fisheries and aquaculture are expected to experience economic losses due to climate change too, for example through changing habitats, an increasing risk of diseases, or water stress.

Map 3.2 **Annual average reduction in wheat yields at 2°C of warming by region**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Source: JRC/Copernicus[117].

Increasing and volatile food prices due to climate impacts on food production in Europe represent one of the key risks related to food and nutrition security. Droughts, in addition to factors such as energy and fertiliser prices, can increase the cost of food[24]. For example, in the summer of 2023, prices for Spanish tomatoes, broccoli and oranges increased by 25-35% due to drought-related crop losses[118]. Higher prices for fresh produce may cause dietary shifts towards cheaper but less healthy products, as well as reduced food intake for some of the population[119].

Food security, particularly access to healthy food, is strongly influenced by socio-economic drivers, including fiscal policies such as value-added tax (VAT), taxation and subsidies, which can impact affordability. Adjusting these policies — for example, by reducing VAT on fresh produce or reallocating subsidies toward healthier food options — could enhance access to nutritious food and improve affordability, particularly for disadvantaged groups. This, in turn, would support human health and social justice.

Nearly 60 million people experienced moderate or severe food insecurity in 37 European countries in 2021. Around a fifth of this figure can be attributed to an increase in heatwave days and drought months, compared with the average in the 1981-2010 period. The increasing frequency of droughts meant that 3.5 million more people were food insecure in 2021 than the annual average for 1981-2010. People who have a low income have a statistically significantly higher risk of food insecurity compared to people on a median income[100,120].

Forestry

Forest fires are a threat to forests and natural areas in Europe, including protected areas that are home to endangered plant and animal species. Every year, approximately 80,000 hectares (ha) are burned in Natura 2000 areas, hindering biodiversity conservation in European countries. In 2023, 118,084 ha burnt in Natura 2000 areas, equalling about 27% of the total burnt area that year[121]. Wildfires release huge amounts of GHGs; for example, the emissions from wildfires in the EU and the United Kingdom (UK) between 1 June and 31 August 2022 were estimated at 6.4Mt CO_2e[122], which is close to the total emissions for the whole year of 2022 of countries such as Cyprus or Luxembourg. Further, fires and other climate risks to forests result in GHG emissions and can affect their carbon removal capacity[123].

Forest growth and stability in the EU have also been negatively impacted by severe and frequent droughts. Forest tree health has deteriorated, particularly since 2018, due to prolonged and severe drought events in central Europe, sparking a significant bark beetle infestation. As a result, widespread tree mortality has been observed, and large amounts of preventive felling have taken place to mitigate further tree mortality[123].

Wind damage is likely to increase with warming winters, as the period during which soil is frozen decreases, making trees more vulnerable to windthrow. Other extreme events have also intensified under the changing climate, such as downpours, floods or short-duration heat waves, inflicting physical damage on plants and trees[123].

Energy

Climate risks for energy security vary across Europe. Overall, southern Europe faces increasing risks from heat, droughts and water scarcity, whereas northern Europe is likely to experience both risks and opportunities.

Major climate risks for the European energy system include increased demand for cooling. In 19 European countries, the amount of final energy used for cooling in residential buildings tripled between 2010 and 2019. In the EU-27, the amount of energy used for cooling in residential buildings represented only 0.4% of the total final energy consumption in the residential sector in 2019. However, this percentage was much higher in southern European countries such as Malta, Cyprus and Greece, at 11%, 10% and 5%, respectively[124]. Future energy demand for cooling will increase the most in southern EU countries. In the future, Greece, Italy, Portugal and Spain could consume 71% of total annual energy use for cooling in residential buildings in the EU[125,126].

Coastal floods, inland floods, storms, wildfires and other climate-related hazards can damage energy production and transmission infrastructure and disrupt energy supply, cascading to all economic sectors but also to human health and well-being. Other risks are regional reductions in hydropower potential owing to reduced water availability, reduced efficiency of thermal power plants and electricity transmission, and impacts of extreme weather events on energy infrastructure. Prolonged droughts affecting electricity supply in combination with heatwaves affecting peak electricity demand could lead to power cuts, particularly in southern Europe[24].

Built environment and infrastructure

The impacts of extreme weather events pose a serious risk to Europe's built environment and infrastructure, with grave implications for human well-being. Currently, around 12% of the European population live in areas potentially prone to river flooding, although in many cases there are flood defences in place. In addition, 11% of healthcare facilities and nearly 15% of industrial facilities in Europe are sited in potential riverine flood-prone areas[127]. In the period 2017-2019, in each of those years on average 119,000 people in the EEA member countries and the UK, lived in areas assessed as burnt by wildfires[115].

This risk is further exacerbated by the ageing condition of many of Europe's buildings and infrastructure. For example, in the EU over one-fifth of the building stock was built before 1945 and over 75% before 1990[128]; the average age of the sewers for 36 cities included in the Urban water atlas for Europe[129] is 40 years[130]. This not only means that some of the built environment is in disrepair but also that it was constructed for different conditions than the climate of today and tomorrow.

The continuing patterns of unsustainable development — placing both residential and non-residential buildings in areas prone to flooding, droughts or wildfires — cause economic losses and put human health and well-being at risk. Between 2011 and 2021, there was an increase of over 935,000 people in Europe (1.8%) living in potential riverine flood-prone areas[127]. In addition, the current insurance practices — based on the 'build back the same' principle — are not fully adapted to the changing climatic conditions.

The impacts of extreme weather on critical infrastructure and buildings not only cause economic losses but can also exacerbate the health and societal consequences of climate change. For example, for health facilities, structural damage from flooding — both river and coastal — and windstorms is expected to increase, with expected annual damage rising from EUR 250 million per year in the 2000s to EUR 520 million per year in the 2080s[131]. The expected annual damage from coastal flooding in EU Member States and Norway has been projected to increase from EUR 1 billion in 2020 to EUR 1 trillion by 2100 under a high-emissions scenario[132].

Poorly adapted dwellings and workplaces can increase the risk of heat stress for the population during heatwaves[24]. In general, buildings throughout much of Europe have not been designed to deal with heat. The urban heat island effect — urban areas experiencing much warmer temperatures than the surrounding rural areas — further exacerbates heatwaves; this especially affects vulnerable populations and the facilities supporting them. Across European cities, 46% of hospitals and 43% of schools are in areas at least 2°C warmer than the regional average due to the urban heat island effect[133]. Initiatives are being taken across Europe to mitigate and cope with the risks associated with urban heat, and Box 3.2 provides an example of such efforts.

Box 3.2

Staying cool and connected: Kassel's heat telephone for seniors

As global temperatures rise, urban heat islands amplify health risks. In Kassel, Germany, summer can be up to 6°C hotter than nearby rural areas. The city's elderly population — over 40,000 residents aged 65 and over — is especially vulnerable.

To address this, Kassel launched the Heat Telephone programme in 2010 under its KLIMZUG-Nordhessen climate adaptation strategy. Originating from a neighbourhood conference on seniors' health during heatwaves, the pilot's success spurred a citywide rollout by 2011, driven by public interest.

Each summer from June 15 to August 31, registered seniors receive phone calls whenever the German Weather Service issues a Level 2 heat warning — indicating a perceived temperature above 38°C. During these calls, trained volunteers share timely and practical coping tips and safety measures. These conversations also serve as welfare checks, allowing volunteers to spot distress or health issues and, when necessary, alert the individual's general practitioner for timely intervention.

The telephone remains the most reliable way to reach many seniors who may lack digital skills. Beyond weather alerts, these calls foster care, connection, and build trust. Manfred Aul, head of the seniors' advisory board, says chats often evolve into valuable conversations.

The programme relies entirely on volunteers, many of whom return annually, strengthening bonds with participants. Yet this dependence poses challenges: during prolonged heatwaves, volunteers may face their own vulnerabilities or caregiving duties. Maintaining service sustainability requires exploring more resilient, long-term support structures.

According to Markus Heckenhahn from the Kassel Health Department, the initiative's flexibility is a core strength: call frequency and content adjust daily to weather and participants' needs. Its low-cost, high-impact model has inspired interest from other cities. Future plans include expanding to other vulnerable groups, such as the chronically ill[134].

Transport and mobility

Climate change can pose major risks to all modes of water- and land-based transportation. Transport infrastructure is vulnerable to weather-induced hazards, including changing precipitation patterns, temperatures, sea levels, coastal and river floods, droughts, erosion, marine heatwaves and ocean acidity.

Climate change exacerbates risks, potentially disrupting normal functioning or leading to infrastructure failure during severe weather events. Heatwaves cause thermal expansion, road and railway buckling, and the softening of road asphalt and pavement material. Rapidly changing temperatures around the freezing point of roads can make road surfaces and the main road structure deteriorate. Urban roads and railways are also vulnerable to extreme winds, while heavy rainfall impacts underground transport systems. Metro/subway systems face challenges from climate change, including heavy rainfall, storm surges and storms. Airports and harbours, particularly in low-elevation coastal areas, are at risk due to rising sea levels[24].

Droughts could reduce navigation capacity in rivers, impacting inland waterway transport; those risks are lower in northern Europe and highest in the southern Danube region. Meanwhile, in mountainous regions, precipitation-induced landslides affect transport infrastructure[24].

In relation to air transport, projections for Europe include a significant increase in hazardous levels of air turbulence and more frequent severe thunderstorms, with associated larger risks to aircraft and ground equipment related to hail and lightning strikes. An increase in the duration and intensity of heatwaves also has the potential to cause damage to ground infrastructure, equipment and escalating health risks for passengers and personnel. Air transport may also be affected by airport closures due to extreme weather, more frequent and intense dust- and sandstorms from the Sahara and changes in jet streams and wind direction[135].

Current damage in the transport sector primarily results from river floods and heatwaves, accounting for approximately 51% and 27% of the total expected annual damage (EAD) (EUR 800 million per year) in the 2000s. Costs associated with weather-induced hazards are projected to increase significantly by the 2080s, potentially reaching over EUR 10 billion; this would be a twenty-fold increase from the current level. Heatwaves are expected to be the dominant factor, accounting for 92% of total damage by the 2080s, particularly affecting roads and railways due to rutting and blow-ups[131].

Sectorial greenhouse gas emissions and mitigation measures

Climate change affects each sector differently, as does each economic sector's contribution to Europe's GHG emissions also varies. The largest decreases in GHG emissions are observed for energy supply, industry and buildings, while the reductions in agriculture and transport have been slower (Figure 3.7). Towards 2030, European Commission modelling indicates that there are likely to be additional reductions across all sectors with the least reductions in agriculture. The remainder of this section provides details related to GHG emission trends for each of the sectors. A broader system-level analysis is provided in Chapter 5.

Figure 3.7 Trends of greenhouse gas emissions by sector, 2005 to 2030

Notes: The model-based emissions in the MIX 55 scenario refer to a core policy scenario underpinning the 2030 Climate Target Plan from EC, while the emission data for 2005 and 2023 are from EEA[95].

Source: EEA[95].

Energy

The overall reduction in net GHG emissions already achieved in the EU can be largely attributed to shifts in energy production methods, notably a significant decline in coal usage and growth in the adoption of energy from renewable sources (Section 3.2.2 for details). This trend has led to a continuous decrease in GHG emissions in the energy supply sector over recent decades, with an average annual GHG reduction of 3% since 2005. In the past 5 years, this rate has accelerated to over 6% per year[98].

Industry

GHG emissions from the industrial sector have significantly decreased over the past decades, by an average of 2% per year since 2005 and by 4% per year over the past 5 years. At the same time, overall economic activity (measured as gross value added) from the manufacturing sector in Europe has increased, indicating decreased GHG emission intensity. The reduction in industrial GHG emissions can largely be attributed to improvements in energy and material efficiency, along with notable decreases in emissions from certain production processes[98].

Buildings

GHG emissions from the combustion of fossil fuels for space and water heating in buildings have consistently decreased, with annual average reductions of 2% since 2005 and over 3% over the last 5 years. Although the number and size of houses have increased, better insulation, use of less carbon-intensive fuels and reduced heat demand due to milder winters have resulted in these reduced emissions. The buildings sector is projected to play a key role in reducing GHG emissions in Europe in the next decade, with an expected increase in the deployment of heat pumps, district heating systems based on renewable energies and an increase in the renovation rate as key contributing factors[98].

Agriculture and LULUCF

The agricultural sector has only experienced a modest reduction in GHG emissions, averaging 0.4% per year since 2005, with the rate growing to 1.1% over the past five years[98]. Since 2005, this was largely due to reductions in methane emissions from enteric fermentation and improved manure management, as well as a reduction in nitrous oxide emissions from more efficient fertiliser use on agricultural soils. Other agricultural emissions are included in the energy sector (as combustion) and in the LULUCF sector.

In 2023, the LULUCF sector was responsible for a net sink of -198 Mt CO_2e and counterbalanced around 6% of EU emissions from other sectors[98]. However, the LULUCF sink has been declining for about a decade. The sector provided an average annual carbon sink of -335 MtCO_2e in the period 1991-2013. Yet between 2014 and 2023, the average annual sink was 30% smaller compared to the decade before. This decline is driven by a combination of interrelated factors, including the ageing of forests, an increase in harvesting, climate change impacts and ecosystem degradation[136]. Cropland and settlements are the major sources of net emissions in LULUCF, driven by factors such as the management of organic soils and the conversion of land with high carbon stock to settlements. The increasing impacts of climate change on forests, as well as ecosystem degradation, affect the predictability of the LULUCF sector in delivering carbon removals in the future[24].

Domestic transport and mobility

GHG emissions from transport — of which 75% relate to road transport — have decreased only slightly since 2005, at an average of 0.3% per year. Over the last 5 years the reduction increased to an average of just under 1% per year. This slow pace in emission reductions is the result of two counterbalancing factors. On the one hand, growth in both passenger and freight transport activity has increased total GHG emissions. On the other hand, the lower CO_2 intensity of new cars, partly driven by the fast deployment of electric vehicles (EVs), is helping to reduce the sector's GHG emissions[95].

3.3 Pollution and environmental health

3.3.1 Introduction

What is covered?

A multitude of environmental risks are harming the health of European citizens, including outdoor and indoor air pollution, transport noise, water and soil pollution, exposure to harmful chemicals, extreme cold, heatwaves, radiation (mainly indoor radon), climate-aggravated exposures to pathogens, occupational exposures, aeroallergens, inadequate housing and second-hand tobacco smoke, among others. On the other hand, environmental assets like urban green spaces, clean rivers and water bodies, healthy forests and biodiversity are helping protect human health and well-being and reducing climate-related environmental risks.

In general terms, high-quality natural resources are essential for human health since they underpin the delivery of basic human needs, including critical services such as drinking water and sanitation, healthy food and clean air. While high-quality ecosystem services are critical to health, polluted ecosystems pose risks to health (Figure 3.8).

This section focuses on the health implications of pollution, specifically outdoor air pollution, water pollution, chemicals and noise. It provides knowledge on what measures and actions are being taken to protect Europeans from risks and move towards the 2050 vision to reduce pollution to levels that are no longer considered harmful to health.

For other environmental risk factors, such as indoor air pollution, inadequate housing, aeroallergens and several toxic chemicals, no comprehensive pan-European estimates are available on their impacts on human health. The effects of extreme temperatures and other climate-sensitive exposures are analysed in Section 3.2 of this report.

Figure 3.8 **Ecosystem services that support health, against risks to health from a polluted environment**

Human health and well-being are intrinsically linked to healthy environments.

10% of premature deaths in Europe are linked to environmental risk factors.

94% of the EU urban population are still exposed to hazardous $PM_{2.5}$ concentrations.

Annually, noise in Europe causes 66,000 premature deaths and 50,000 new cases of cardiovascular disease.

Several hazardous chemicals are present above safe levels in our bodies and the environment.

Facts and figures

Some socioeconomic groups are more exposed to pollution and more impacted by it than others. It is critical to address these inequalities.

Over 30% of Europe's population lives in areas where transport noise levels are harmful to health.

Nearly half of European waters failed quality standards set to protect human health. Pollutants include persistent chemicals such as mercury, brominated flame retardants and PFOS.

A range of chemicals are known to be present at unsafe levels in Europe's environment and in European citizens, including PFAS, cadmium, mercury and bisphenol A.

239,000 premature deaths were attributable to $PM_{2.5}$ in the EU in 2022.

Children, including unborn children are particularly impacted by pollution, leading to lifelong impacts, and therefore particularly benefit from clean and healthy environments.

The risk of zoonotic disease spread from animals to humans is reduced when habitats are protected and biodiversity losses are addressed.

Key trends in Europe

Air quality has improved significantly over the past decades for most pollutants.

The EU is on track to reduce health impacts of air pollution by >55% by 2030.

The EU is on track to reduce the use and risks of chemical pesticides by 50% by 2030.

The EU is not on track to meet the noise target for 2030. The number of people highly annoyed by transport noise declined only by 3% between 2017 and 2022.

* Waterborne pathogens, vectorborne pathogens, radon, second-hand smoke, aeroallergens, etc.

Source: EEA, 2025.

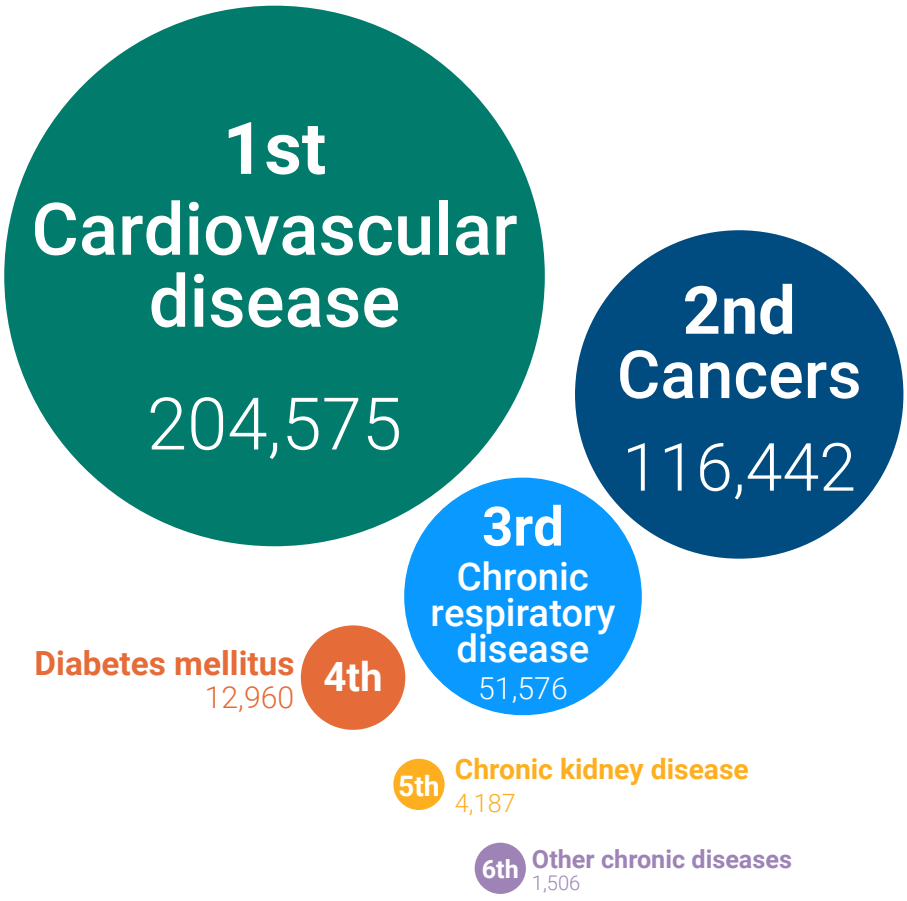
Why is it important?

The United Nations (UN) recognises pollution, together with climate change and biodiversity loss, as one of the three planetary crises[137]. Each one of these crises, as well as their interactions, affects human health.

Pollution continues to reduce quality of life in Europe significantly, with at least 10% of premature deaths in the EU-27 driven by exposure to polluted air, water and soil, noise and harmful chemicals[138]. Exposure to pollution can result in illnesses such as asthma, allergies, cancers, reproductive and developmental disorders or cardiovascular diseases, which can reduce the quality of life of citizens and make them more vulnerable to the impacts of other risks such as heatwaves.

In Europe, pollution drives chronic disease, with deaths from non-communicable diseases resulting from exposure to environmental risks shown in Figure 3.9. There are also inequalities in exposure to pollution with those in lower socio-economic groups tending to have higher exposure, while vulnerable groups can also be disproportionately impacted by exposure to pollution. For example, children exposed to chemicals such as mercury (Hg) or lead (Pb) have a higher risk of lifelong impacts on mental development.

Figure 3.9 **Top six non-communicable diseases causing deaths attributable to the environment in high-income European countries, 2021**



Source: EEA[139].

Environmental risk factors contribute significantly to the burden of disease in Europe, contributing to an estimated 18% of deaths related to cardiovascular disease, around 10% of deaths related to cancer and over 30% of deaths related to chronic respiratory disease[140,141,142].

Current figures on the health impacts of pollution in Europe are very likely underestimates, as they include only pollutants for which enough data are available. In some cases, like environmental noise, data coverage on measurements is clearly insufficient. For many pollutants, science is still uncovering their effect on many health outcomes. For several chemicals, a solid understanding of the long-term effects and exposure concentrations, as well as the potential effects on health when found in combination in the human body, are lacking. In the case of some known pollutants, health impacts are being observed at levels previously considered safe.

What is the EU doing?

With more than 40 different pieces of legislation in place, the EU has been working for decades to protect human health and the environment from the impacts of pollution. There is a range of relevant existing directives and regulations; these seek to reduce emissions of air and water pollutants (e.g. the national emission reduction commitments (NEC) directive, the industrial and livestock rearing emissions directive (IED 2.0), the revised urban wastewater treatment directive (UWWTD)), control chemical production and use (e.g. the regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH regulation) and regulation 1107/2009 concerning the placing of plant protection products on the market) and the management and reduction of environmental noise (the environmental noise directive).

While many of these have been successful in reducing health impacts, it is widely recognised that further initiatives are required to ensure that an integrated approach is taken to addressing pollution. In response to this recognition, the EC has adopted the ZPAP and the Chemical Strategy for Sustainability as the main policy initiatives under the EGD to guide the way towards a toxic-free environment.

The ZPAP aims to integrate pollution prevention into all relevant EU policies. It includes a number of measurable policy targets, including reductions in premature deaths attributed to fine particulate matter ($PM_{2.5}$), the number of people chronically disturbed by transport noise, ecosystem areas adversely affected by air pollution, nutrient losses, the use and risk of chemical pesticides, the sale of antimicrobials, plastic litter, microplastics, total waste and residual municipal waste. All these targets are to be reached by 2030. Progress towards these targets is reviewed in Section 3.3.2. The ZPAP also includes a longer-term vision, for 2050, for air, water and soil pollution to be reduced to levels no longer considered harmful to health and natural ecosystems and for the boundaries with which our planet can cope to be respected, thereby creating a toxic-free environment.

The global dimension

Pollution knows no borders: many chemicals and air pollutants can affect regions far away from the sources of emissions and some have natural sources. Clear examples of transboundary pollution include long-range transport of air-pollution and industrial accidents the effects of which cross borders.

The outsourcing and offshoring of production facilities from Europe to regions with less stringent (and less costly) environmental protection legislation can increase pollution and its health impacts in those regions. It can also create knowledge gaps on the types of chemicals that are present in the products imported by the EU; this can potentially result in unrecognised risks to European consumers. Therefore, it

is important that pollution is also dealt with at the international level. On the other hand, globalisation can also promote the relocation of technology, usage of green technologies and expansion of rigorous environmental standards which could potentially help prevent pollution.

However, another negative factor is that global population and economic growth results in increased demand for goods and services leading to increased emissions of air pollutants and consumption of chemicals worldwide. This is underpinned by the fact that the number and volume of chemicals on the global market have grown substantially over recent decades[143].

What is the current state at the European level?

Table 3.3 compiles past trend assessments over the last 10 to 15 years, outlooks for 10 to 15 years ahead and assessments of the prospects of meeting 2030 and 2050 EU policy targets (where available) from the six thematic briefings related to the environment and human health. Details on the assessments, as well as on cross-cutting drivers and pressures, are provided in Sections 3.3.2 to 3.3.4.

Table 3.3 Overview of assessment results on environment and health

Briefing	Emissions of pollutants to air	Air pollution and impacts on human health	Environmental noise and impacts on human health	Water pollution and human health	Chemical pollution and human health	Environmental health inequalities related to air pollution
Past trends (10-15 years)						
Outlook (10-15 years)						
Prospects of meeting EU policy targets for 2030						
Prospects of meeting EU policy targets for 2050						

Improving trends (are expected to) dominate/largely on track to meet policy targets

Trends (are expected to) show a mixed picture/partially on track to meet targets/highly uncertain

Deteriorating trends (are expected to) dominate/largely not on track to meet policy targets

No specific policy targets

Source: Environment and health briefings of *Europe's environment 2025*.

3.3.2 Past trends

Policy responses and an increased regulatory focus have resulted in improvements in certain areas, in particular in emissions of pollutants to air and how air pollution impacts human health (green colour for past trends in Table 3.3).

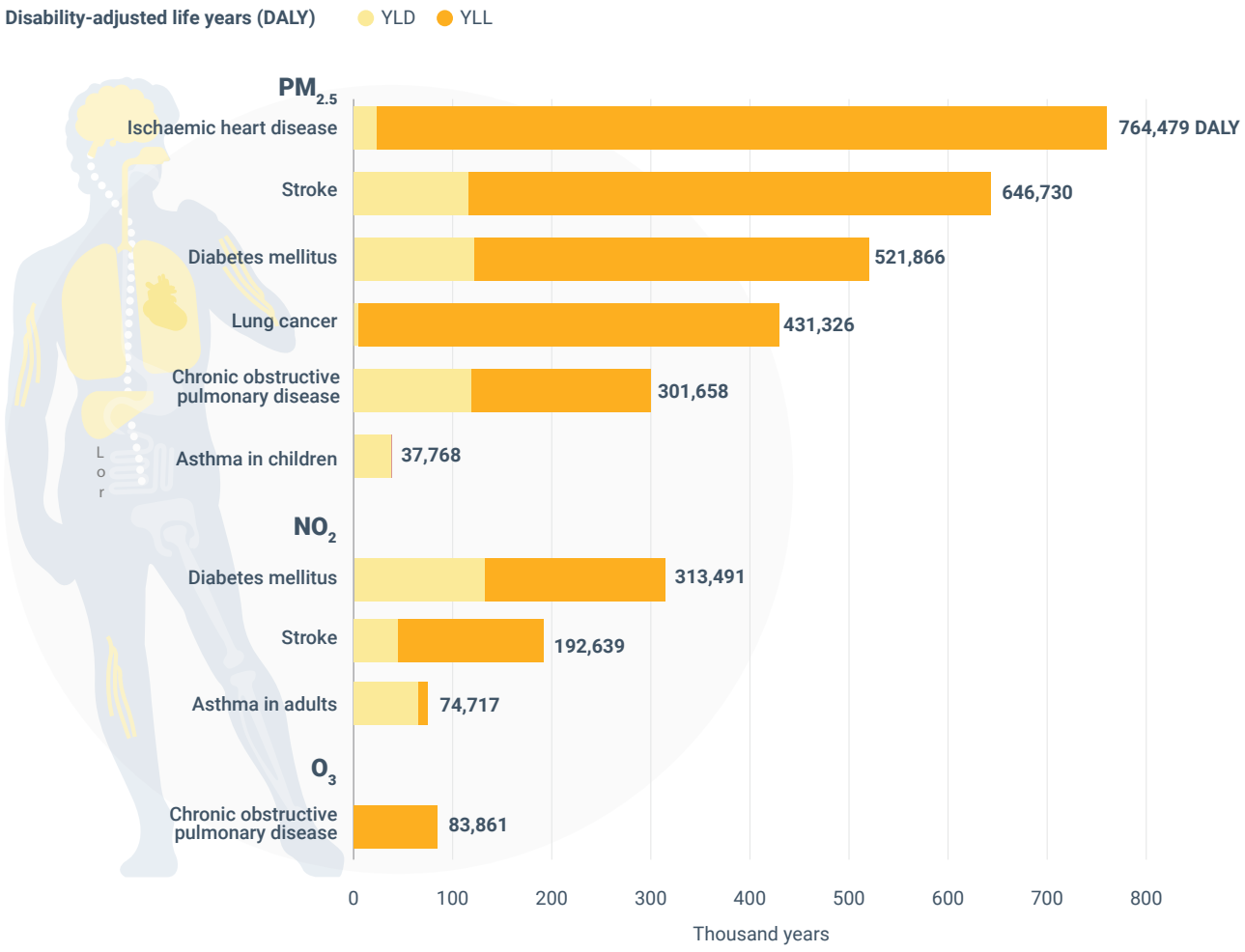
Air pollution

Europe now enjoys cleaner air[31]. Emissions of all pollutants reported under the NEC directive show downward trends since 2005, with largest emission reductions for SO_2 (85%), followed by NO_x (53%), NMVOCs (35%), and $PM_{2.5}$ (38%) by 2023. Concentrations of the main pollutants in air, except O_3, have also decreased[144]. This

has resulted in a decrease in the number of deaths in the EU from 2005 to 2022 attributable to exposure to $PM_{2.5}$ of 45% and to nitrogen dioxide (NO_2) of 53% (for details see briefings 'Emissions of pollutants to air' and 'Air pollution and impacts on human health').

Nevertheless, in 2022 an estimated 250,000 premature deaths were attributable to air pollution in the EU; these were due to a range of causes, including ischaemic heart disease, stroke, diabetes and various respiratory diseases. In addition to premature mortality, the impacts from living with diseases related to air pollution are significant, in particular for stroke, diabetes mellitus, chronic obstructive pulmonary disease and childhood asthma[145] (Figure 3.10).

Figure 3.10 **Burden of disease due to exposure to fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2) and ozone (O_3), 2022**



Notes: A disability-adjusted life year (DALY) is one lost year of healthy life due to disease or injury. DALYs are obtained by adding years of life lost (YLL) and years lived with disability (YLD) for the same disease or group of diseases. YLLs are years of potential life lost due to death caused by a disease or group of diseases. YLDs are years a population has lived in reduced health due to a particular health outcome.

Source: EEA[145].

Noise pollution

There has been a slight decrease in the number of people exposed to high levels of noise from road, rail and air traffic. However, it is estimated that approximately 150 million people — over 30% of Europe's population — are exposed to unhealthy noise levels (i.e. above WHO guideline thresholds); this figure rises to over 50% in many urban areas[146]. Road traffic remains the predominant source of noise pollution in both urban and rural areas (for details see briefing 'Environmental noise and impacts on human health').

In terms of the human cost, living in an area affected by transport noise is associated with an increased risk of developing a wide range of health issues, including cardiovascular, metabolic and mental health diseases. Chronic exposure to transport noise negatively affects children, especially because they are in an important learning and developmental phase. Children living or attending school in areas impacted by transport noise tend to score lower on reading comprehension and face more behavioural challenges, with over half a million children in Europe experiencing impaired reading ability due to transport noise. Almost 60,000 cases in Europe of behavioural difficulties in children are due to environmental noise generated from transport[147].

Water pollution

Compliance with the drinking water directive is high, with most European citizens enjoying access to clean drinking water. Groundwater provides about 62% of the EU-27's drinking water[148], with 77% of the area covered by Europe's groundwater having good chemical status for the period 2016-2021[15]. Nevertheless, freshwater used for drinking water production needs increased treatment due to the presence of micropollutants; this, in turn, raises the cost. Concerns in this area relate to the presence of per- and polyfluoroalkyl substances (PFAS) and microplastics in drinking water, with future monitoring of PFAS foreseen under the drinking water directive[28].

Bathing water quality has improved significantly over the last four decades[149]. In 2023, 85% of bathing waters were rated excellent in the EU and minimum water quality standards were met at 96% of sites[149].

The EU has made consistent progress in expanding its wastewater treatment coverage. The proportion of the EU population connected to at least secondary wastewater treatment — referring to a biological treatment process designed to reduce the amount of organic materials — reached 81% in 2022[28]. Nevertheless, discharges of untreated wastewater from unconnected houses and storm overflows continue to pollute surface waters[150,151] (for details see briefing 'Water pollution and human health').

Chemical pollution

There is a downward trend in the use and risk of chemical pesticides[152] and in the use of the more hazardous chemical pesticides[153]. At the same time, the organic farming area almost doubled from 5.9 to 10.5% of total EU land area in the period 2012 to 2022[64,154]. However, positive impacts are currently uncertain or not well-documented, and the assessments of pesticide use are hampered by methodological challenges. Progress has also been made in reducing the use of veterinary antimicrobials, with a 28% reduction in their use for food-producing animals in 2022 compared to 2018[155].

More industrial chemicals have come under scrutiny by EU authorities. The number of chemicals registered under the REACH regulation and under assessment by EU

authorities has increased substantially since 2010, from around 50 to over 2,000[156]. In some areas, however, while improvements have been observed, the changes have not been at a sufficient level to mitigate the impacts.

Even though some progress on chemicals has been observed, as noted above, it has not been sufficient to mitigate the impacts of the increasing number and volume of chemicals. Data from human biomonitoring — measuring chemicals in people's bodies to better understand chemical exposure — show that the bodies of EU citizens are contaminated by a range of chemicals, in some cases exceeding safe levels in a significant part of the European population and thus posing a potential risk to health[157]. In addition, so-called legacy substances (e.g. mercury, PCB, dichlorodiphenyltrichloroethane, etc.) persist in the environment perpetuating human exposure.

Finally, it is difficult to identify clear trends in the substitution of substances of concern with safer and more sustainable alternatives. Instead, the use of some of the most harmful chemicals is still increasing and thus the past trends assessment given in Table 3.3 is red. Compliance with regulatory requirements is a prerequisite for achieving the health protections offered by the respective regulations and directives. Products imported from outside the EU have a relatively high rate of incompliance (approximately 25%) with EU regulations, which could put citizens' health at risk[158,159].

Chemical pollution in surface waters remains a significant risk to the aquatic environment and human health, with only 30% of surface water bodies having a good chemical status. It is estimated that around 2.8 million potentially contaminated soil sites exist in the EU[160]. Though the use of chemical pesticides has decreased since the baseline period of 2015-2017, this decrease has not yet resulted in reduced pesticide levels in surface waters and soils[161,162].

Knowledge around the magnitude and types of hazards and health risks related to many pollutants is still lacking, including emerging pollutants such as certain PFAS (e.g. trifluoroacetic acid), ultrafine particles and black carbon (which also increases global warming). For details on chemical pollution see the briefing 'Chemical pollution and human health'.

Health inequalities and cross-cutting factors

The unequal impact of environmental pollution has not significantly improved. For example, average pollutant concentrations remain higher by about a third in the poorest regions of Europe compared with the wealthiest. The needs of socially deprived communities and vulnerable groups must be addressed systematically across policy domains. Universal measures to deliver overall reductions in exposure to environmental stressors for the general population can be complemented by measures targeted at groups known to be vulnerable in terms of their increased exposure, increased sensitivity or reduced resilience (for details see briefing 'Environmental health inequalities related to air pollution').

The European Environment Agency has consolidated evidence on how environmental risks contribute to death and disease, to demonstrate how reducing pollution and adapting to climate change will lead to healthier lives for all. For example, exposure to air pollution, heat and cold, noise, second-hand smoke and chemicals (notably lead) are estimated to cause over 18% of cardiovascular disease-related deaths in Europe[141].

At the same time, exposure to air pollution, carcinogenic chemicals, radon, ultra-violet radiation and second-hand smoke together may contribute over 10% of the cancer burden (encompassing new cases, deaths, and the prevalence of the disease) in

Europe[140]. Cancer is the most prevalent type of non-communicable disease and the second most common cause of death after circulatory diseases. Adding to the human costs, the economic costs of cancer are enormous, estimated at around EUR 178 billion in 2018. The life of nearly every European is affected by cancer in some way.

More information on trends, drivers and impacts of pollution can be found in the European Zero Pollution Dashboards[163] and the European environment and health atlas.

3.3.3 Outlook and prospects for meeting policy targets

Good implementation is key to reaching policy targets. EU policy responses have been initiated under the EGD with the aim of reducing the effects of pollution and increasing overall protection levels. However, the impact of these policies will take time to materialise and is dependent on efficient implementation. In this context, the ZPAP plays a key role in addressing pollution by integrating prevention into all relevant EU policies, enhancing implementation, and identifying gaps or trade-offs. It promotes sustainable prosperity by transforming production and consumption, with investments in cleaner technologies, circular economy models, low-emission transport, and nature-based solutions.

Regulatory responses have also been initiated under the EGD umbrella, with a long list of regulations and directives being updated or being scheduled for update. These changes include strengthening the protection level in the individual legislations and also better coherence between them. An important feature in the expected upcoming regulation on 'one substance — one assessment' is the introduction of a more proactive and preventive approach to chemicals through the establishment of an EU early warning system for emerging chemical risks.

The One Health approach (Box 3.3) recognises that human health is interconnected with the health of animals, plants and wider ecosystems and that pollution, climate change and ecosystem degradation can generate risks to human health. For example, antimicrobial resistance is driven by excessive and inappropriate use of antimicrobials in humans and animals, leading to over 800,000 human infections and approximately 35,000 deaths every year in the European Economic Area[164].

Another example is infectious diseases originating from zoonotic pathogens, with the emergence of such pathogens linked to habitat loss, changes in land use and human interactions with animals in the food system. The COVID-19 pandemic was zoonotic in origin and provides a stark example of the inextricable links between human health and ecosystem health.

Box 3.3

The One Health approach

Taking a One Health approach means that ensuring actions to prevent, predict, detect and respond to health threats take into account the interlinkages between human, animal, plant and ecosystem health. Risk assessors integrate and share knowledge from different disciplines such as veterinary, environmental and human health sciences to assess the risks to health posed by disease vectors or contaminants. Risk managers and policymakers can then address the upstream drivers of risks to health, for instance by reducing human pressures on the environment.

In applying a One Health approach, the European Environment Agency (EEA) collaborates with other EU agencies that have a mandate and significant expertise in the areas of environmental sustainability, public health and food safety, including the European Centre for Disease Prevention and Control (ECDC), the European Chemicals Agency (ECHA), the European Food Safety Authority (EFSA) and the European Medicines Agency (EMA). Since 2023, this collaboration has been further strengthened by the establishment of a cross-agency task force on One Health.

The regulation on serious cross-border threats to health requires the EEA and other EU agencies to collaborate on rapid risk assessments of threats to public health, including those originating from the environment or climate. Similarly, the EEA partners with the EFSA and ECDC, as well as the EC, in the context of the European Climate and Health Observatory. This contains a wide range of information about health risks associated with climate change, such as the increased suitability of many areas of Europe for the transmission of vector-, water- or food-borne diseases.

Air pollution

National, regional and local authorities have implemented their own measures to contribute to reducing emissions of air pollutants; these will be key in the continuous improvement of air quality. Systemic changes will be needed to perform and/or complete the transition to more sustainable systems, which entails reducing pollutant concentrations to levels as close as possible to the WHO recommendations. However, it is still necessary to define how some emerging pollutants such as ultrafine particles, ammonia (NH_3) or black carbon impact health. It was not mandatory to assess these until the revised ambient air quality directive (AAQD) was approved in 2024.

All but two Member States need to further reduce their emissions for all the main pollutants to meet their commitments for 2030. However, the projections for sulphur dioxide (SO_2), nitrogen oxides (NO_X), $PM_{2.5}$ and non-methane volatile organic compounds (NMVOC) emissions show a steady downward trend.

The Third Clean Air Outlook report points to further measures to be implemented in the agriculture sector to reduce NH_3 emissions (examples of good practices with beneficial effects include manure storage covering, modern techniques for applying manure to soils, and the use of manure and farm residues to feed biogas plants). Reductions in SO_2 and $PM_{2.5}$ emissions should focus on measures in energy supply (e.g. district heating, building norms to improve insulation, schemas for renovation of household boilers, banning solid fuel) and the manufacturing and extractive industry sectors (e.g. retrofitting of industrial plants), since these two areas are the biggest contributors to these emissions. Efforts to reduce NO_X emissions should focus on the road transport sector (e.g. implementation of low-emission zones, renewal of public transport fleets, and promotion of environmental transportation modes, such as walking and cycling). Meanwhile, the solvent use sectors should be the focus for reducing NMVOC emissions.

Improvement in the information available on air quality as well as campaigns to raise public awareness and to modify behaviour are also crucial elements of any plan to improve air quality.

Noise pollution

The noise pollution outlook depends on different factors. Under an optimistic scenario that includes the implementation of a substantial set of additional measures, the number of people highly annoyed by transport noise is predicted to decline by about 21% by 2030. Under a conservative scenario, this number is predicted to stay unchanged. The large number of people exposed to road traffic noise significantly influences the overall outlook, which indicates that more effort is needed to address road traffic noise. Efforts are also needed to mitigate the negative noise pollution impacts from projected growth in rail activity(146).

Greater progress could be achieved by introducing measures which not only focus on areas with severe noise problems (i.e. hot spots), but also on areas with moderate noise levels, generally below national limits(165). Therefore, implementing a combination of measures to reduce noise at the source is highly important. New EU regulations tackling noise at its source and setting out obligations to act upon critical levels could help reduce the number of people affected by noise(166).

Water pollution

The recast drinking water directive (2020) aims to protect human health from contamination and protect water abstraction points from a wide range of pollutants and micro-organisms. The water reuse regulation (2020) recognises the water availability challenges that some countries are facing, setting out rules to ensure that water reclaimed from urban wastewater treatment plants and used in irrigation meets quality standards.

Meanwhile, the revised UWWTD aims not only to further reduce pollution by nutrients and micropollutants but also seeks to reduce GHG emissions from treatment, achieve energy neutrality, and improve circularity by reusing water and sludge. Focusing on the zero-pollution ambition, the proposed revisions to the water framework/groundwater/environmental quality standards directives would reduce pollution of surface and groundwaters.

Emerging pollutants include the group of PFAS and microplastics. With the exception of a few PFAS like perfluorooctanoic acid (PFOA) and PFOS, which appear to be widespread(167), little Europe-wide evidence is available to date regarding their occurrence in the environment. Overall, and despite the progress mentioned above, it is unlikely that human exposure to complex mixtures of chemicals in the EU will decrease sufficiently to mitigate the risks, mainly due to accumulated legacy substances and continuing exposure to hazardous substances which are still in use.

New rules for urban wastewater treatment will bolster efforts to tackle water pollution under the ZPAP. The revised UWWTD extends the scope to smaller agglomerations, covers more pollutants — including micropollutants — and contributes to energy neutrality. All agglomerations above 1,000 population equivalents — a standard unit used to measure the polluting strength of wastewater — need to have collecting systems in place to capture all sources of domestic wastewater by 2035. Member States will then be required to remove biodegradable organic matter from urban wastewater through secondary treatment before it is discharged into the environment. Previously, this was only required for agglomerations above 2,000 population equivalents.

By 2039, it will be mandatory for urban wastewater treatment plants (treating urban wastewater with a load equivalent to a population of 150,000 and above) to remove nitrogen and phosphorus through tertiary treatment. By 2045, those urban wastewater treatment plants will have to apply an additional treatment to remove micropollutants, known as quaternary treatment. That treatment will tackle micropollutants and microplastics by introducing new standards and monitoring requirements. In line with the polluter pays principle (PPP), producers of pharmaceuticals and cosmetics — the main source of micropollutants in urban wastewater — will need to contribute a minimum of 80% of the additional costs for the quaternary treatment through an extended producer responsibility (EPR) scheme.

Finally, the rules introduce an energy neutrality target: by 2045, urban wastewater treatment plants treating a load of 10,000 population equivalents and above will have to be powered using energy from renewable sources generated by the respective plants[168].

Chemical pollution

The production, consumption and use of chemicals is expected to continue to grow by both volume and number of different chemicals. However, it is also expected that there will continue to be a gradual reduction in the use of more hazardous chemicals. Lack of significant progress in terms of reducing human exposure via the environment can partly be explained by persistent diffuse pollutants, particularly given the release of pollutants into the soil (e.g. pesticides) and water (nutrients and pesticides).

Diffuse pollution is often far harder to address compared to pollution from point sources, which can be abated more effectively. Once released into the aquatic environment, many of these pollutants are highly persistent and continue to pollute water and food for years or decades. Countries will continue to use human biomonitoring data to check for the population's exposure to chemicals and the associated burden of disease[169].

Additionally, electronic records of plant protection products used, together with digital labelling of plant protection products which is envisaged in the near future, will allow accurate data to be collected on the quantities of active plant protection substances utilised on farms, at the national and EU levels. In the future, the data may also be used to identify new and emerging chemical risks and thus contribute to a European early warning system.

The IED 2.0 is expected to further reduce point-source pollution. The increased scope of the directive covers a total of over 70,000 industrial installations, and pig and poultry farms, and covers a range of new activities. This will better enable policymakers and the general public to assess emissions and the environmental performance of large, industrial installations.

Overarching considerations and prospects for meeting policy targets

Prevention is a cost-efficient way to ensure healthier lives, though only 3% of the healthcare budget in the EU is spent on preventive efforts whereas 97 % is used on treatment[170]. Preventing pollution thus prevents disease and, while there is now a broad range of measures in place to continue to address the risks related to pollution, it is critical that Member States fully and effectively implement this suite of legislative measures to further improve health and well-being in the coming years.

The sectors responsible for generating pollution (detailed in Section 3.3.4) are also providing goods and services that increase our quality of life. To reduce

pollution, consumption of products and services can be reduced and scaled-back, or less-polluting processes can be developed to produce the same or better products and levels of service. Here, innovation plays a key role in the transition to a non-toxic environment.

A sufficient degree of innovation will require continuous investment from both the private and public sectors. Additionally, this kind of innovation can be stimulated by soft regulation or market mechanisms. Since the need for goods and transportation is not expected to decline, technological innovations, policy solutions and regulatory measures are key to decoupling products and services from the generation of pollution as much as possible.

The safe and sustainable by design framework is a concrete tool to assist private companies in the innovation stages for new chemicals and materials. It combines and compares multiple different lines of potential impacts covering the entire lifecycle of a product, including both safety and sustainability aspects. This has the potential to reduce levels of hazardous substances in material cycles and prevent the chemical contamination of secondary raw materials acting as a barrier to their re-use (see also Section 4.2).

Regarding the prospects of reaching pollution-related policy targets, a detailed overview of the current status of the specific measurable policy targets from the ZPAP can be found in the *Zero pollution monitoring and outlook*[163]. This report, assessing the ZPAP targets and policy objectives and visions from other official EU documents in combination, shows mixed results. For all six environment and human health topics covered, the prospects of meeting the 2030 policy targets are assessed as either only partially on track or predominantly not on track, while for 2050 all topics except water pollution are assessed as not on track (see colour coding in Table 3.3). More information can be found in the individual Environment and health briefings.

Knowledge gaps

A lack of knowledge is still a barrier to understanding and mitigating pollution and its impacts. Importantly, in this context, current monitoring and reporting does not cover all pollutants significant to health. For example, as discussed in relation to air pollution, it is still necessary to define the impact of some emerging pollutants such as ultrafine particles or black carbon, whose assessment was not mandatory until the approval of the revised AAQD. Bathing water quality is only assessed on the presence and concentration of two bacteria as indicators of faecal contamination.

Additionally, there is uncertainty about the combined effects of mixtures of chemicals on human health and the specific types of emerging effects from chemicals, which are currently inadequately covered by the standard tests. These effects include developmental immunotoxicity, neurotoxicity and endocrine disruption. Taken together, these uncertainties mean that we are likely to underestimate the impacts of pollution on human health.

However, responses initiated to improve our knowledge base include the Partnership for the Assessment of Risks from Chemicals (PARC), which will contribute with research and knowledge towards risk assessment, human biomonitoring and environmental monitoring for chemicals[171]. Other large EU-funded initiatives, such as the EURION cluster[172] on novel testing and identification methods for endocrine-disrupting chemicals (EDCs) and the ENKORE cluster[173] on further elucidating the links between EDCs and several disease outcomes, also contribute to the knowledge base on the impacts of chemical pollution on human health. Additionally, the IDEAL cluster[174] — on indoor air quality and health — and the CUSP cluster[175] — studying the impacts of micro- and nanoplastics on health — provide evidence on the impacts of additional groups of pollutants on human health.

3.3.4 Drivers and pressures

The generation of pollution is intrinsically bound to production and consumption systems, including manufacturing, waste handling, agriculture, energy, transport and healthcare. Some of the key sectors, their drivers and pressures are described in Table 3.4 below.

Table 3.4 Pollution drivers and pressures by sector

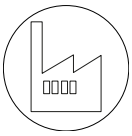
Sector	Drivers	Pressures
Food production (Agriculture)	Widespread use of chemical pesticides, fertilisers and veterinary medicines to maintain crop yields and meat production	Diffuse pollution continues to contaminate water, soil and air, and leading to pest resistance and chronic illnesses in humans. Emission of precursors of secondary pollutants is an ongoing problem with agriculture responsible for 93% of total NH_3 emissions to air, leading to secondary particulate matter when reacting in the atmosphere with SO_2 and NO_X. Diffuse pollution of water and soil from veterinary medicines persists where untreated animal waste reaches surface and groundwaters; where antibiotics are used, this contributes to the threat of antimicrobial resistance(177) to human and animal health(178). There is ongoing contamination of food and feed with pesticide residues; EFSA estimates that around 2.2% of sampled foods have pesticide levels that are not safe(179).
	Use of non-road machinery and burning agricultural waste	Air pollution, including primary pollutants and NMVOCs and NO_X, continues to act as a precursor in the formation of tropospheric O_3.
Residential, commercial and institutional sector	Energy consumption, including burning solid biomass and fossil fuels	Air pollution from energy use in the sector was responsible for 62%, 43% and 36% of reported emissions of particulate matter, $PM_{2.5}$, PM_{10} and black carbon, respectively, in 2022. Domestic heating is a source of ultrafine particles. Discharges of sewage from institutions such as hospitals and care homes may represent high sources of pharmaceuticals, including antimicrobials, to urban wastewater treatment plants. Not all receiving plants can treat such discharges effectively before release to the environment(180).
 Industry	Industrial facilities as major point sources of water, soil and air pollution	This is a major contributor to pollution, though a positive trend has been observed from 2010 to 2022 in industrial releases of pollutants that are hazardous to human health and the environment. However, emissions data for air and water suggest that the trend in reductions is levelling off(181,182). Certain types of industries are also sources of noise pollution.
Transport	Road transport, aviation and shipping as major sources of air pollution Road transport also as a main contributor to noise pollution	Transport is still a major contributor to air pollution, though implementation of vehicle exhaust emission controls to comply with the Euro emission standards and electrification is helping reduce NO_X, $PM_{2.5}$ and NMVOC emissions. Road transport, shipping and aviation are significant sources of ultrafine particles. Noise pollution is one of the most significant environmental impacts from transport activities. In both urban and rural areas, road traffic is the primary source of environmental noise pollution, while noise from railways and aircraft affects smaller segments of the population, with significance at the local level. Policies addressing transport-related noise have not yet led to substantial reductions at the overall EU level, as the projected growth in population and transport activities outpaces the benefits of these initiatives. Polycyclic aromatic hydrocarbons (PAHs) and metals from road transport continue to contaminate Europe's surface waters, from both exhaust emissions and particulates from tyre breakdown(15).

Table 3.4 Pollution drivers and pressures by sector (cont.)

Sector	Drivers	Pressures
Consumer products	Use of toxic natural and synthetic chemicals in a wide range of consumer products	There is continued, direct exposure to toxic chemicals from toys, cosmetics, cleaning products, electronic products, food wrappings, paints and other consumer products, with health impacts documented via human biomonitoring for a number of priority substances such as Bisphenol A, Phthalates, brominated flame retardants, PFOS and PFOA. Exposure to toxic chemicals via the environment persists, e.g. when chemicals are washed down the drain or emitted from washing machines and carried to urban wastewater treatment plants. There, pollutants may be removed from the sewage sludge, treated to become more harmless forms and/or, if very soluble, discharged to rivers and lakes where they may harm the local environment[15]. If very persistent, they can present a long-term threat to the environment and/or human health through food or drink. The use of solvents in paints and several other products increases the emissions of volatile organic compounds, a precursor of O_3.
Energy production and distribution	Use of fossil fuels	Energy supply is the principal source of SO_2 emissions in the EU. There have been relative reductions in NO_X and $PM_{2.5}$ emissions mainly due to the modification of combustion technologies, flue gas abatement techniques and switching from coal to gas. Renewable energy use is only a partial solution, and it is important to address possible trade-offs from climate policies such as the burning of biomass. Hg and PAHs from burning coal for energy production widely pollute Europe's surface waters[15].

4 Managing the dynamic between our economy and our natural resources

Key messages

- Europe's economy is largely dependent on natural resources, in many cases imported from outside Europe. Environmental pressures from resource extraction, along with geopolitical instability, make it vital to rethink how we source and consume natural resources.
- The EU is one of the most intensively used land masses on the globe, with 38.8% of land dedicated to agriculture, 35.3% to forests, and 5.8% to residential and urban areas. As such, there is a need to consider trade-offs across competing demands for land for biomass production, carbon sequestration, renewable energy and ecosystem restoration.
- Water pollution, over-abstraction and physical changes impact water bodies, groundwater and wetlands, with climate change exacerbating these issues. Deterioration in water quality creates risks for production-consumption systems, especially food, industry and energy. Water stress affects 30% of Europe's territory and 34% of the population each year. This is likely to increase in the future due to climate change.
- Raw materials feed Europe's industrial economy and sustain our high quality of life. Our food, housing and mobility systems together account for more than 80% of the EU's total material footprint. Decarbonisation and electrification are driving demand for critical raw materials, for which the EU is heavily dependent on imports from a limited number of non-European countries.
- Only 11.8% of all material demand in the EU is sourced from recycling, and the EU is still far from its ambition to double its circularity rate by 2030. Yet, circularity practices and business models, along with policies to address high levels of consumption, can lower resource use and reduce waste while reducing the EU's dependence on material imports.
- There is an urgent need to reduce material consumption within the EU, which is unsustainable and much higher than in most other world regions. International supply chains mean that much of the environmental degradation driven by the extraction, processing and use of resources to fuel EU consumption occurs outside the EU. Efforts to reduce the EU's material footprint should address the demand for resources along the entire value chain.

4.1 Competing priorities for natural resources

European natural resources — including land, clean water and raw materials — upon which our production and consumption systems are based, are finite. Importing material and energy resources from outside Europe has allowed Europe to overcome these limits but has also exposed our economy to dependencies, geopolitical risks and price shocks. In this context, strategic autonomy has emerged as a political priority.

This section explores competing priorities for natural resources in Europe and considers how progress in climate change mitigation and circularity has affected how we use resources. It argues for the need to identify and resolve trade-offs between environmental, economic and social demands through sustainable resource management and practices ensuring that decarbonisation, circularity and nature restoration go hand in hand. More broadly, responsible stewardship of natural resources, grounded in a recognition of geophysical limits and aimed at long-term regeneration, will secure the resilience of Europe's vital societal functions as defined in the Preparedness Union Strategy.

The section builds on the thematic briefings on 'State of Europe's biodiversity', 'Pollution of ecosystems', 'Protected areas', 'Water and climate impacts', 'Ecosystems and climate impacts', 'Land use and land take', 'Soil resources', 'Trends in the energy system', 'Water pollution and human health', and 'Waste generation and material consumption'.

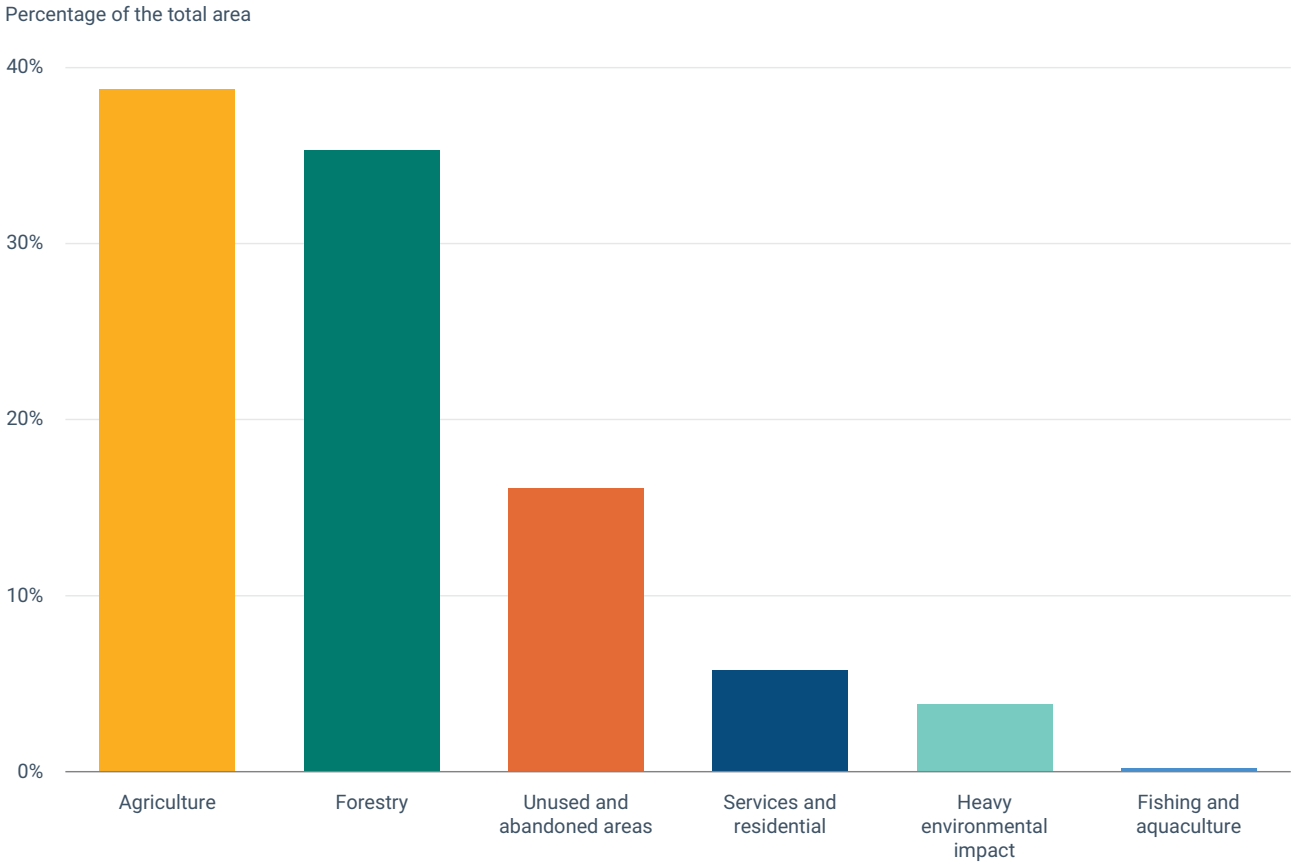
4.1.1 Land

Europe is one of the most intensively used land masses on the globe, with a significant proportion of land dedicated to agriculture, forests and, to a lesser extent, urban areas and infrastructure. The way our key production and consumption systems — food, energy, mobility, industry and the built environment — use this land impacts our environment and climate.

In the EU in 2022, 38.8% of land was agricultural, 35.3% was forest, and 16.1% was unused and abandoned land. A further 5.8% of land was used for services and residential purposes, while uses with a heavy environmental impact claimed 3.8%, leaving 0.2% for fishing[1] (Figure 4.1).

In terms of land set aside for biodiversity, in 2022, protected areas covered 26.1% of EU land, with 18.6% of EU land designated as Natura 2000 sites and 7.5% under other complementary national designations[2].

Figure 4.1 Main land use by land use type in the EU



Notes: Services and residential purposes include commerce, finance and business; community services; recreation, leisure and sport; residential; and nature reserves. Uses with a heavy environmental impact include mining and quarrying; energy production; industry; water and waste treatment; and construction.

Source: Eurostat[1].

Looking forward, the EU's agricultural and forest land is projected to remain stable between now and 2035 but with relative changes in the share of different types of land. The amount of agricultural land under permanent crops is expected to increase, while permanent grassland, fodder and fallow land remains stable[3].

Land inputs in Europe's production and consumption systems

Land use underpins the provision of biomass (Box 4.1). It also provides space for residential areas, and infrastructure for transport and energy systems as well as natural ecosystems supporting biodiversity and ecosystem services. Competition for EU land stems from demand for biomass for food, bioenergy and materials set against the expectation that land will contribute to carbon sequestration, provide nature-based solutions to support climate adaptation and deliver on targets for nature restoration.

Climate-induced changes, including floods, droughts and shifts in temperature and precipitation patterns, will intensify pressures on land-use planning. As such, there is a need to prioritise how land is used to produce biomass and for what purpose, in a the context of competition for EU-sourced biomass to fulfil future policy objectives[4].

Box 4.1

Biomass in the EU

Biomass is defined as renewable, organic material that comes from plants and animals, as well as the biodegradable elements of products, waste and residue from biological origins. As a major component of ecosystems, it sequesters carbon, and provides food for animals and humans. It also delivers feedstocks for a wide range of bio-based materials in use in sectors such as the construction, energy, transport, furniture and textiles.

The EU used 1.2 billion tonnes of dry matter biomass in 2017, of which 50% was used for food, feed and bedding for livestock, 22% for bioenergy and 28% for materials[4]. Biomass use in the energy sector has been growing since 2005; in 2023 biomass made up half of EU renewable energy consumption[5].

Using biomass as a substitute for fossil fuels and other carbon-intensive materials can support the defossilisation process in the energy, transport and building sectors. This increases demand for biomass, driving land use change and reducing stocks of the remaining, unharvested biomass left in ecosystems. While biomass use in energy generation is seen as carbon neutral, the process of regrowth and CO_2 sequestration can take several decades, while the use of biomass in energy via combustion releases significant amounts of CO_2 and other pollutants into the atmosphere over the short term[4].

Looking ahead, research indicates a growing gap between biomass demand and supply. It also indicates that there will not be enough EU-sourced biomass available to fulfil all its roles as envisaged in the European Green Deal (EGD) in the future. Sustainable biomass sourcing will need to ensure that biomass harvesting does not exceed the natural growth rate needed to maintain biodiversity and ecosystem structure, functioning and productivity in Europe and elsewhere[4].

The EU's food system is highly reliant on land use, with food production directly dependent on nature. Farms managed 38.4% of all land in the EU as utilised agricultural area in 2020[6]. The type of land use varies according to climate and geography, with agriculture dominating land use in a few Member States (72% in Ireland and 62.6% in Denmark). This contrasts with Finland and Sweden where forestry dominates. While the number of farms in the EU has been decreasing — falling by 37% between 2005 and 2020 — the amount of land used for agricultural production remained broadly unchanged over the same period due to growth in the number and size of the largest holdings[6]. Box 4.2 provides an example of the stewardship of agricultural land in Menorca, Spain.

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Box 4.2

Agricultural land stewardship Menorca, Spain

Environmental context and spark for action: over the years, farming on the island of Menorca has changed. Farms are generally now larger and produce more intensively, which negatively impacts biodiversity. In 2004, the non-governmental organisation (NGO) Grup Balear d'Ornitologia (the Ornithology and Nature Defence Group, GOB) started a strategic alliance called the 'Land Stewardship Initiative'. This aims to support small-scale local sustainable food production that benefits the local economy and biodiversity.

Policy/societal impact: the Land Stewardship Initiative is a network of agro-ecological farms. It currently brings together 38 farms covering about 4% of Menorca. Farms that join the initiative sign a 'Sustainable Agricultural Practices Agreement' which adheres to three fundamental values: health, nature and proximity. Under this agreement, GOB and the farmers work together to ensure the economic viability of the farm and the island on the one hand, and the conservation of nature and traditions on the other.

Actions/outlook: GOB supports the farms directly or by providing marketing strategies for the farm products. The initiative aims to provide healthy food, strengthen the local economy, and reduce carbon and ecological footprints. It includes training for farmers (in skills such as farming techniques and marketing), organises for GOB representatives to engage in school education programmes and arranges volunteer days at the farms. Another crucial aspect of the NGO's success is the network of agro-ecological farms, which offers farmers a platform to support and learn from each other[7].

The EU's food system also exerts indirect pressure on land outside its territory due to its reliance on land abroad to meet domestic consumption needs — commonly referred to as the EU's land footprint. For example, in 2021, it is estimated that EU-imported products required approximately 50 million hectares (ha) of cropland — roughly the size of Spain — while exporting products associated with around 28 million ha. This made the EU a net importer of about 22 million ha of cropland[8].

The food system also relies on healthy soils that filter out pollutants, buffer against chemical degradation, and store and provide important nutrients, as well as water. Healthy soils also host a huge diversity of organisms, acting as engines for ecosystem functions, such as nutrient cycling and carbon storage. Yet, 62% of all soils[9] and 89% of agricultural soils show signs of critical function loss.

Estimates suggest that loss of soil biodiversity and critical levels of subsoil compaction — the compression of soil layers typically at depths greater than 10 cm and often caused by farming practices with heavy machinery — are widespread phenomena, though monitoring is required to provide further evidence[10]. At the same time, vegetation and soils are among the planet's major carbon sinks. However, in Europe, this sink is decreasing because of factors such as the state and age of the EU's forests, the impacts of climate change, land use changes, the increased harvesting of wood and adaptation of forests to climate change. Forest land and harvested wood products account for significant carbon removals but cropland, grassland, wetlands, settlements and other land uses contribute to net emissions[4].

The future of the EU energy system will be defined by renewable energy sources, with a binding EU-level target to ensure that at least 42.5% of the energy share is delivered by renewables by 2030 (compared with 24.5% in 2023)[11]. A recent estimate found that 5.1% of EU land area in needed to maximise the potential of onshore wind and solar projects, mostly in rural areas[12].

The availability of land for renewables varies across Member States. Some countries, such as Germany and Italy, struggle to identify enough land suitable for deploying more renewables while other countries, such as Spain and Romania, have abundant land resources for their development[13]. Multifunctional land-use solutions, such as integrating solar panels with agricultural activities, will become increasingly important[4].

The renewable energy directive allows Member States to designate certain areas as suitable for renewables acceleration; these benefit from simplified processes for permissions to speed up the massive roll-out of renewable energy projects. However, depending on approaches to permissions and deployment, an increase in solar energy production could increase existing conflicts over land use. As such, the colocation of agriculture and solar power — so-called agrivoltaics — could be one solution to optimise land-use efficiency.

Moreover, the potential to scale up solar photovoltaics (PV) on existing infrastructure — such as rooftops, and along public rail and road networks — has been estimated to exceed 1 terawatts (TW); this is far greater than the objective of 700 gigawatts (GW) from solar PV by 2030 in the EU's solar energy strategy. That means, if only a part of this potential were realised, it would help to achieve the 700 GW objective[14,15].

Similarly, for onshore wind, the JRC (Joint Research Centre of the European Commission) calculated that 530GW of untapped potential remains available: 84% in rural areas, 14.6% in towns, and suburbs and 1.4% in cities[12]. These calculations excluded protected areas, included arable land only under strict criteria, and added a 700 m buffer around settlements of any size. This would ensure that noise levels fall below 40 decibels (dB) in these areas, even in the case of large turbines.

While this potential is clearly significant, in practice, competent authorities must be sufficiently resourced and skilled to address the trade-offs around siting onshore wind farms; these include noise and potential impacts on landscapes or wildlife[16]. New spatial planning and cumulative risk assessment tools can enhance the effectiveness of such decisions. However, more needs to be done to ensure community acceptance of projects and ensure a fair distribution of benefits and costs between the local, regional and national levels.

For offshore wind, the potential is also significant. Europe aims to increase offshore wind energy production, with a large share of the future network to be in sensitive coastal zones. At the same time, Europe also aims to increase the proportion of marine protected areas from 12.3% in 2022 to 30% by 2030. Establishing new sites for offshore wind in coastal zones — with a water depth down to 60 m — should take into account the potential negative impacts on vulnerable coastal areas; these include cumulative pressures from climate change but also fisheries, maritime transport, agriculture and other sea-based human activities.

Synergies also exist, with offshore wind installations offering space for fish stocks to recover, or for sustainable aquaculture. Ecosystem-based maritime spatial planning can help deliver a for co-existence between clean energy, the protection of marine environment and adequate space for other uses, including transportation, fishing and recreation[17]. Europe's planned expansion of offshore wind should build on the implementation of maritime spatial planning to align climate and biodiversity policy goals[17].

The mobility system also requires land for roads and infrastructure, given Europe's car-centric urban planning system. Smart mobility systems will require land to be repurposed for new roads, rail and other adapted networks. The consistent increase

in transport activities[18] suggests the need for land for new infrastructure is unlikely to decrease unless demand management measures are consistently put in place.

Impacts of production and consumption systems on land

The demand for land from Europe's production and consumption systems competes with the needs of biodiversity. Increasing land-take — the conversion of natural and semi-natural land into artificial land[19] — puts pressure on biodiversity, degrades habitats and contributes to issues ranging from decreasing carbon sequestration to soil sealing, landscape fragmentation, increased flood risks and urban heat island effects[20].

To help restore balance, a key target of the EU Biodiversity Strategy for 2030 is to protect at least 30% of the land and 30% of the sea in the EU by 2030. Restoring ecosystems can allow nature-based solutions to be implemented that build resilience to the impacts of climate change, with examples provided in Box 4.3.

Box 4.3

Examples of nature-based solutions related to agriculture, water management and coastal areas

Agriculture: Nature-based solutions (NbS) help to deal with drought, water scarcity, increasing temperature and flooding in agriculture. The case studies Soil structure improvement in Heilbronn district, Germany and Crop diversification in Segovia, Spain, demonstrate the applicability of NbS options in agroforestry and conservation agriculture to improve soil conditions and build resilience to climate change.

Water management: Nature-based solutions are used to manage water of river basins, through the Establishment and restoration of riparian buffers, and the Rehabilitation and restoration of rivers and floodplains. The case study Flood and drought risk management in Serchio River basin, Italy demonstrates how NbS can help transform agriculture and urbanisation land use and address a multitude of challenges highly exacerbated by climate change.

Coastal areas: Nature-based solutions are applied as dune construction and strengthening and beach and shoreface nourishment in coastal areas to contrast erosion from sea level rise induced by climate change. For example, the case study Coastal erosion management in the Marche region, Italy, shows how both options were used, while also applying elements of climate change adaptation in the integrated coastal zone management plan.

Source: EEA[21].

Food production in the EU is the system that demands the largest area of land, thereby putting pressure on habitats and species, and driving biodiversity loss[22]. Land use for biofuel production also provides well-documented cases of trade-offs with biodiversity[23,24]. Similarly, forest ecosystems face conflicting demands, with the need to increase carbon storage at the same time as providing a source for the extraction of wood for materials and bioenergy, as well as preserving biodiversity and maintaining cultural ecosystem services, such as recreation, tourism and education[4].

Converting land to the built environment increases impermeable surfaces and runoff, exacerbating the risks of flooding. It also puts land out of use for other purposes, including for nature and biodiversity, causing habitat fragmentation and decreasing the resilience of ecosystems[25].

Regarding the quality of land, soil compaction is a common issue that affects soil properties and functions across Europe, though the extent and severity of compaction remain difficult to determine[26]. Key drivers of this phenomenon are agriculture and forestry, through activities such as monocropping and raising livestock in high density. Compaction reduces water infiltration and the ability of plants to establish deep roots. Such degradation directly impacts soil fertility and crop yield at the same time as increasing the risks of surface water runoff and flooding.

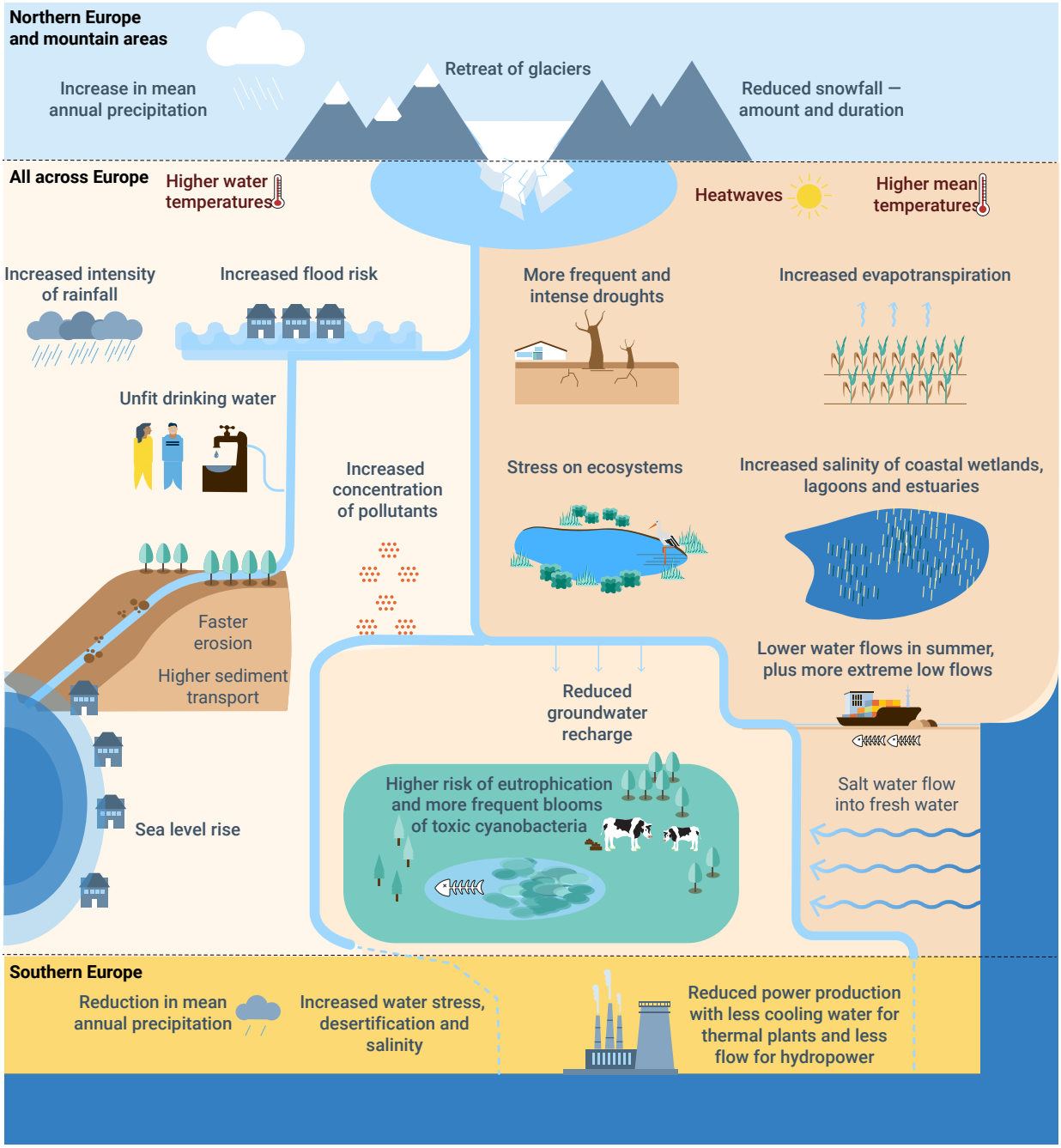
Given the poor state of many ecosystems, there is an urgent need to reconcile and articulate the demands on land from primary sectors and across systems to ensure a sustainable, long-term supply of primary raw materials. The ongoing failure to sustainably manage terrestrial and marine ecosystems and protect ecosystem services is putting entire sectors at risk; it reduces their capacity to deliver vital supplies such as food and biomass and also limits their capacity for carbon storage.

4.1.2 Water

Clean water is crucial for ecosystems and human health, and as a resource for our key production and consumption systems. Ensuring sufficient, high-quality water for all needs is not only a European but a global challenge. Water pollution, over-abstraction and physical changes (such as river straightening) impact waters and wetlands, with climate change exacerbating these issues; the effects are seen in groundwater, rivers, lakes and coastal waters, with ecosystem services negatively impacted as a result. On average, water stress affects 30% of Europe's territory and 34% of the population every year. These figures are likely to increase in the future due to climate change through a range of mechanisms (Figure 4.2).

Despite some progress, there has been no overall reduction in the area affected by water scarcity and the situation has even intensified since 2010. This, compounded with the fact that climate change is expected to further increase the frequency, intensity and impacts of droughts, makes it unlikely that water scarcity will be reduced by 2030. While overall Europe has enough water to meet its needs, there are significant differences in how water scarcity is impacting southern and northern Europe, with Cyprus and Malta facing the most significant water scarcity conditions of all the EU Member States on the seasonal scale[27].

Figure 4.2 **How climate change impacts water**



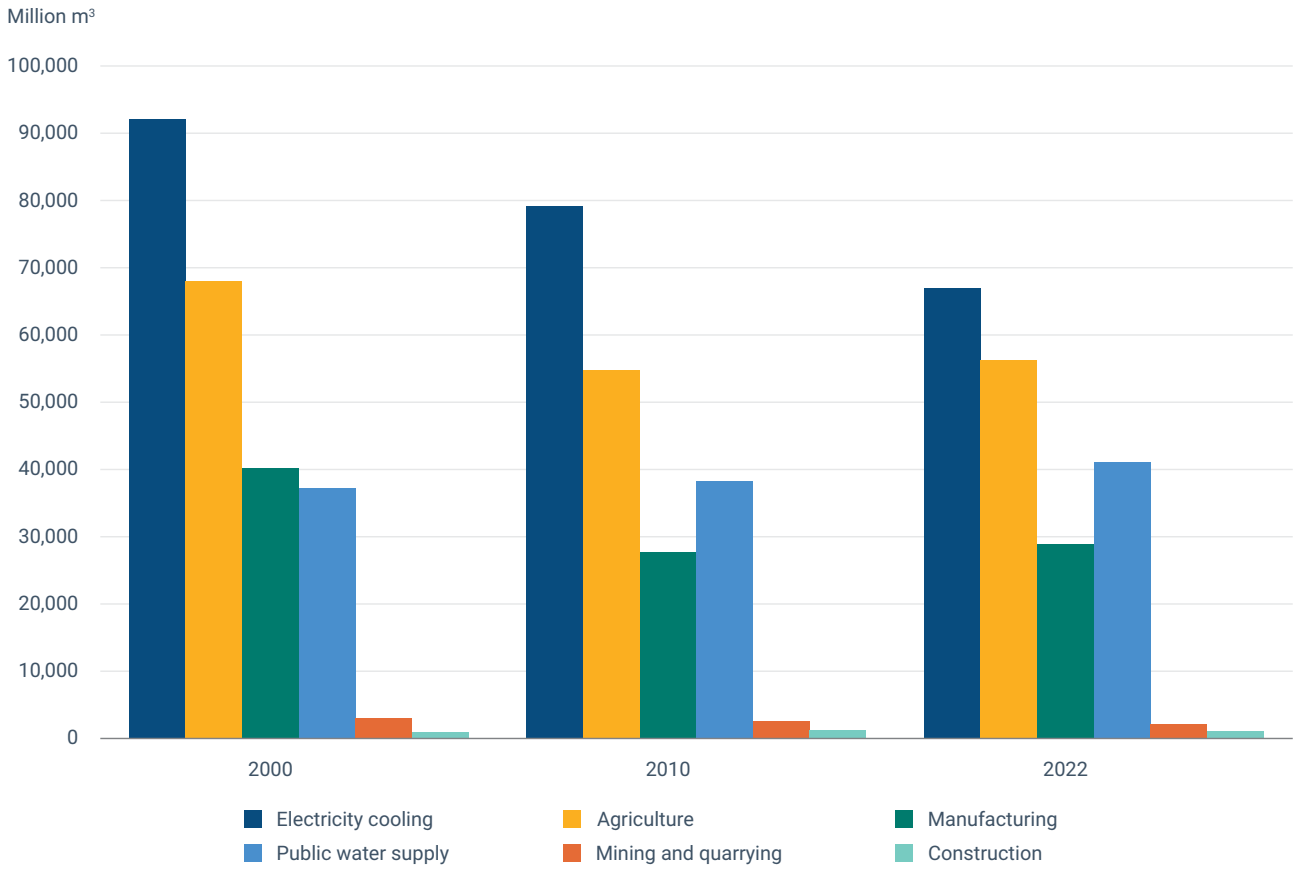
Source: EEA[28].

Water inputs in Europe's production and consumption systems

EU Member States have reduced their total water abstraction by 19% from 2000 to 2022 (Figure 4.3) due to better water conveyance (transport of water from its source to where it is needed), efficiency of use and socio-economic changes, especially in eastern Europe. However, the goal to reduce water abstraction to below 20% of

renewable freshwater resources by 2020 has not been achieved in all European river basins and it seems unlikely that this will be achieved soon[29]. Most water is abstracted for electricity cooling, agriculture, manufacturing and public water supply (Figure 4.3).

Figure 4.3 EU water abstraction by economic sector, 2000, 2010 and 2022



Source: EEA[30].

The sectorial shares are different for net water consumption, which also takes into the account the amount to water returned to the environment. In the EU, agriculture uses 59% of all water[28]. That means, as most of the water is consumed by the crop or evaporates and is not returned to the environment, agriculture is by far the highest net water consumer in Europe. Without changes in practices, demand from irrigated agriculture is likely to increase with climate change[28]. Water is essential for irrigating crops, maintaining ecosystems and sustaining livestock. Due to the large share of water consumed during the growing season (spring-summer), seasonal issues with water availability occur in most of the EU. In regions with limited water resources, this can lead to severe shortages and resource conflicts over competing uses. When the demand for water exceeds supply, drinking water supply and food security are threatened.

Countries across Europe are taking action to manage water use in agriculture to bolster water resilience. The measures include integrating water reuse practices in irrigation and shifts in how, where and when crops are grown, with an example from Spain provided in Box 4.4.

Box 4.4

Protecting Spain's Doñana wetlands through sustainable water use in agriculture

The Doñana wetlands in south-western Spain, a UNESCO World Heritage Site, face severe hydrological stress due to decades of unsustainable water use. In 2023, a legislative proposal to legalise unauthorised groundwater extraction and expand irrigable land threatened to worsen the situation. The wetlands, vital for biodiversity and regional livelihoods, have seen surface water inputs drop to just 20% of historical levels, largely due to river isolation, land drainage and tributary degradation.

Groundwater overexploitation — driven by intensive berry farming and tourism — has further reduced water levels in lagoons and ponds, and shortened water retention. While individual actors bear responsibility, the crisis reflects deeper institutional failures in water governance, including weak enforcement, poor inspections and flawed administrative controls.

Public scrutiny and media investigations linked supermarket supply chains to environmental degradation in Doñana, prompting reputational risks for retailers. In response, major food retailers began demanding verifiable water sustainability practices from suppliers, showing how market forces can drive change.

The controversial proposal was ultimately withdrawn due to pressure from NGOs, scientists, civil society and retailers. This led to the Acuerdo por Doñana, a EUR 1.4 billion joint plan by national and regional governments to restore the wetlands. Key measures include curbing illegal water extraction, incentivising land renaturalisation and improving wastewater treatment.

Doñana's case highlights the importance of integrated water resource management in agriculture. Sustainable water use is essential not only for ecological preservation but also for the long-term viability of farming and tourism. Coordinated action among governments, market actors and civil society is critical to safeguarding water resources and ensuring resilient ecosystems[31].

Water is also used for generating hydropower and for operating nuclear and fossil fuel power stations; they rely on vast quantities of water and cause the temperature in rivers and lakes to increase, with consequent ecological impacts[32]. Moreover, with the onset of climate change, the cooling capacity of water can fluctuate or be reduced. Additionally, drought threatens water capacity for power supply[33].

Waterways are also crucial for transporting goods, yet severe weather events like droughts or floods can disrupt these routes, hindering the delivery of materials and impacting sectors dependent on water transport. In the built environment, construction projects, green spaces and urban cooling systems depend heavily on water. During heat waves, cities require substantial water supplies to cool down buildings, and maintain parks and gardens to ensure a liveable environment.

Many industries consume large amounts of water. The textile industry uses water to grow cotton and for dyeing and finishing fabrics[34]. Mining operations, while limited to specific locations, need large amounts of water to process minerals and suppress dust. As digitalisation accelerates, data centres play an increasingly important role in the deployment of digital solutions supporting the transition to a sustainable, low-carbon economy, but they also rely on large quantities of high-quality drinkable water to cool down processors[35].

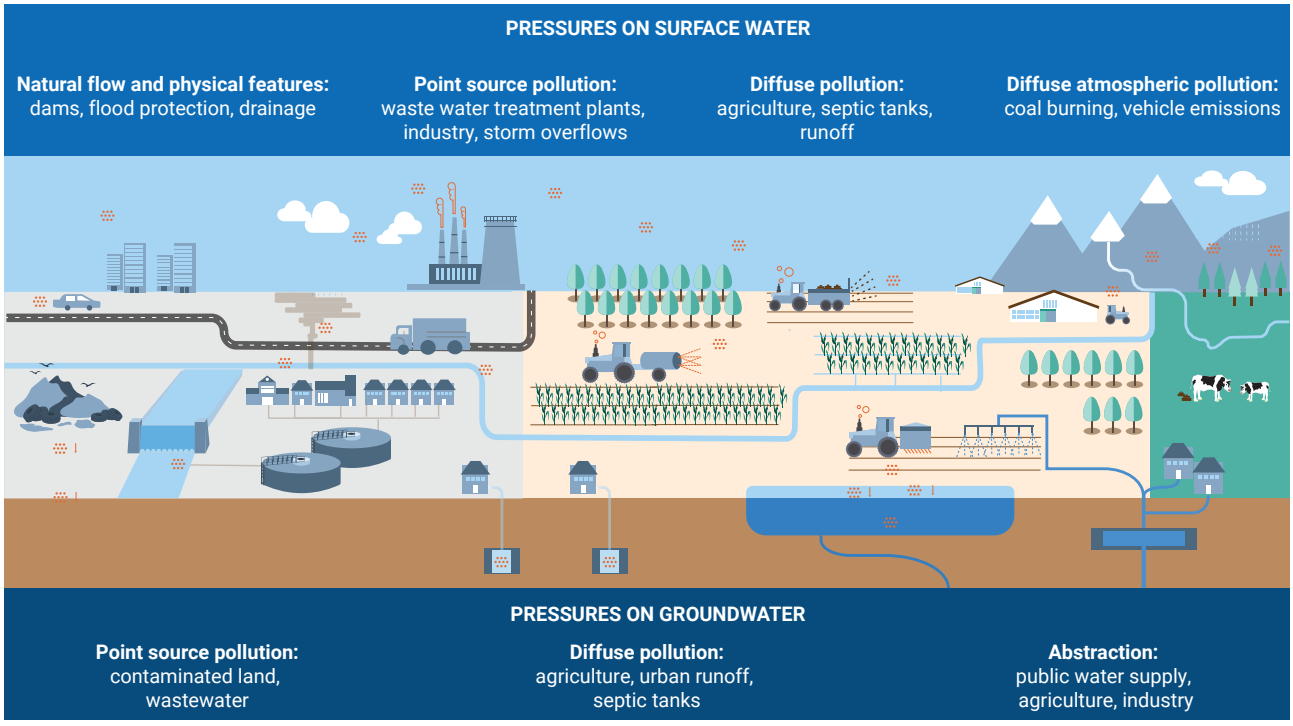
The recently adopted European Water Resilience Strategy (introduced in Chapter 2) has the potential to address multiple pressures through initiatives such as providing

guidance on how to reduce water consumption and improve water efficiency, activating public and private funding to reduce leaks in pipes and modernise water infrastructure, promoting exchange of best practices in saving water, or supporting sound water pricing policies.

Impacts of production and consumption systems on water

Production and consumption systems in Europe pose multiple pressures on surface water and groundwater, through point source pollution, diffuse pollution, water abstraction, and atmospheric pollution (Figure 4.4). Agriculture is the most significant pressure affecting both surface and groundwater[28]. Greater progress has been made in reducing industrial pollution to air than to water, and, as such, environmental impacts in water ecosystems remain high[36].

Figure 4.4 **Pressures on surface and groundwater**



Source: EEA[28].

Surface water is affected by diffuse atmospheric pollution from the burning of fossil fuels (accounting for 49% of pressures from pollutants on all EU surface waters); diffuse pollution from agriculture and point source pollution from discharges from urban wastewater treatment plants also considerably add to the pressure (29% and 12% respectively)[37]. The main pressures on groundwater are diffuse pollution, especially from agriculture (32%), and abstraction (18%), most commonly from agriculture, public water supply, and industry[28].

The use of fertilisers and pesticides in farming practices can lead to runoff of these substances into rivers, lakes and groundwater. Fertiliser runoffs contribute to degraded water quality by increasing nutrient levels in water, which promotes excessive algae growth; in turn, this leads to broader ecosystem impacts, such as depleted oxygen levels and loss of aquatic life. Likewise, average concentrations of

nitrates in groundwater have not decreased over the 2000-2021 period[38]. Regarding pesticides, at 10-25% of all surface water monitoring sites reported to the EEA between 2013 and 2021, one or more substances were detected above their effect threshold — the level above which the pesticide's impact is considered harmful[39].

Generating hydropower involves constructing dams for hydroelectricity that cause major changes in hydro-morphological flows and reduce river connectivity. Almost 9,000 new barriers and dams for hydropower production are planned or already under construction in parts of Europe; the large majority are small hydropower plants[28]. In this context, best practices to avoid or strongly reduce ecosystem impacts must play a more significant role during the licensing process and in the operation of existing hydropower plants. Meanwhile, potential trade-offs with the ambition to create 25,000 kilometres (km) of free-flowing rivers by 2030[40] should be properly assessed. Box 4.5 shows an example of the benefits of reopening waterways by removing dams and other barriers.

Box 4.5

Restoring the Pärnu river basin for migratory fish in Estonia

Estonia's largest river restoration project has transformed the Pärnu river basin, which comprises one-sixth of the country's waterways and serves as its second-longest river and prime salmon habitat. For decades, dams blocked about 90% of prime spawning grounds for salmon and other migratory fish, with the Sindi dam — just 14 km from the river's estuary — posing the greatest barrier.

In 2015, the Estonian government acquired the Sindi dam and surrounding land for EUR 1.3 million. Its removal in 2019 reopened vital migration corridors. Subsequent efforts demolished two additional dams on the main stem and five on tributaries, restoring 3,300 km of river channels and markedly improving ecological conditions.

This initiative was part of a EUR 15 million programme co-funded by the EU Cohesion Fund and Estonia's state budget. It revitalised historic migration routes and elevated the conservation status of 32 aquatic species. Recent studies document dramatic habitat expansions: river lamprey now access spawning areas 5.6 times larger than before, while vimba bream spawning grounds have increased elevenfold. Salmon and other migratory species have begun extensive recolonisation across the basin. Salmon populations have begun to spawn better and their young are surviving more across reopened stretches, underlining long-term benefits of barrier removal.

Beyond ecological gains, the restoration has galvanised local communities. Canoeing, swimming, fishing and eco-tourism prospects are flourishing, promising new revenue streams and fostering stronger connections between residents and the river. The Pärnu river basin project exemplifies how nature restoration can yield environmental, social and economic dividends, breathing new life into ecosystems and communities alike[28].

The large-scale deployment of more recent technologies, such as battery electric vehicles (BEVs), also calls for a more proactive approach to the identification and mitigation of potential impacts on water beyond Europe's borders. For example, in the case of BEVs, the overall impacts of BEVs on freshwater ecotoxicity and eutrophication can actually be higher than those of petrol or diesel vehicles ,when taking into account energy use, mining and manufacturing operations that take place outside Europe[41]. However, these potential global impacts can be reduced with appropriate measures, for instance by accelerating the decarbonisation of the energy system within Europe. They could also be mitigated by reducing pressures from

mining and manufacturing activities outside Europe through diversifying sourcing of critical materials or investing in green technologies and responsible mining, by introducing domestic recycling targets, and by increased production within Europe.

When pollutants infiltrate groundwater, it can lead to significant costs in treating drinking water to protect human health. The natural return of polluted groundwater to rivers and wetlands can also result in risks to wildlife[42]. Pollution of this vital resource for humans and all other living species is a critical threat to our health and economy.

Reducing pressures from industrial activities, intensive agriculture and other human actions is essential to improve water quality and availability, and enhance biodiversity and freshwater and marine environments. Actions are being undertaken at the country, regional and local levels, with an example of good practice from a city in the Netherlands provided in Box 4.6.

Box 4.6

Managing urban flood risks with swales in Enschede, the Netherlands

As cities face increasingly extreme rainfall patterns due to climate change, traditional drainage systems are often rendered inadequate, causing peak discharges into surface water, sewer overflows and seasonal imbalances in groundwater levels. In response, the Dutch municipality of Enschede implemented an innovative drainage solution in a new housing development in 1999, using swales (shallow and vegetated channels) as a nature-based approach to manage rainwater sustainably.

The system collects all surface runoff through street-level gutters, keeping water flows visible and engaging for residents. Rainwater is directed into a network of swales where surplus water is diverted through gullies to an underground infiltration system made of expanded clay particles wrapped in geotextiles. This system is engineered to balance water needs year-round. In dry periods, it allows for infiltration into groundwater, and during wet conditions, it manages drainage to prevent excess water buildup.

Drainpipes beneath the swales distribute or drain water depending on groundwater levels, effectively addressing both summer drought and winter saturation. Monitoring from 1999 to 2005, with follow-up studies conducted in 2022 and 2023, showed that about 99% of runoff infiltrated the ground instead of entering surface water or sewers. Swales typically emptied within 24 hours, and infiltration capacity remained consistent over time.

Cost-wise, the swale system proved slightly less expensive to build than conventional sewer systems, though ongoing maintenance costs are somewhat higher. However, early and active involvement of local residents played a vital role in the project's success. Community engagement helped build support and reduce opposition and led to user-driven improvements.

The swales case in the Netherlands demonstrates how smart, decentralised water management systems can reduce urban flood risk, enhance groundwater recharge and foster local stewardship in the face of increasing climate pressures[28].

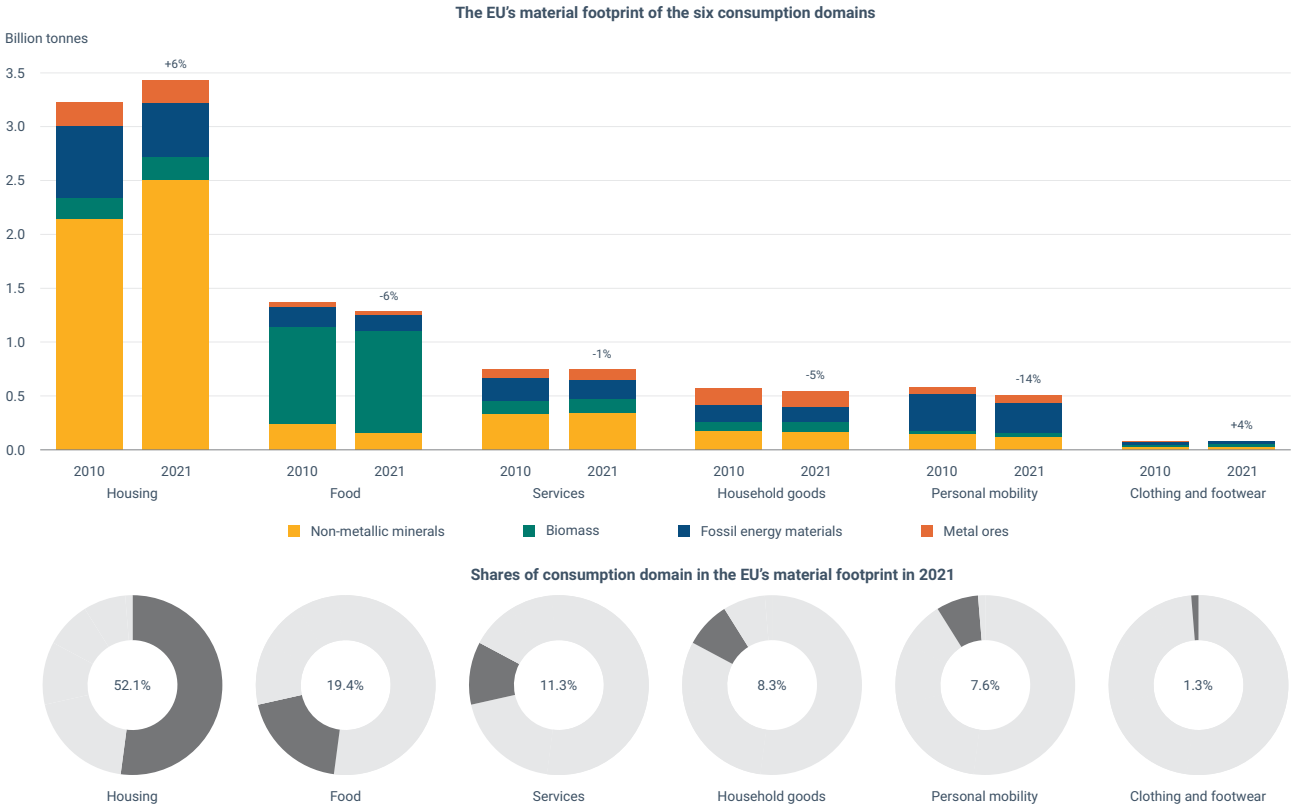
4.1.3 Raw materials

Raw materials are fundamental to Europe's industrial economy and ambitions to achieve a digital and green transition. Many materials are limited, and this increases competition for them. Additionally, extracting and processing raw materials often has adverse environmental and social impacts. These materials include fossil fuels, biomass such as timber, non-metallic minerals such as sand and gypsum, as well as metals such as copper, iron and gold. In addition, critical raw materials — while accounting for only a small share of all materials used — are both of high economic importance and also at high risk of supply disruption[43].

Raw material inputs in Europe's production and consumption systems

Overall, the food, housing and mobility systems together account for more than 80% of the EU's total material footprint (Figure 4.5). Different production and consumption systems drive demand for different materials. Housing is the primary driver for non-metallic minerals. The food system, in contrast, creates high demand for biomass materials — three-quarters of the total EU demand. Almost half of the material demand for personal mobility are fossil fuel materials. These differences in material demands affect the environmental and climate pressures exerted by each system, as the environmental footprint of materials differs significantly (see Figure 4.10).

Figure 4.5 The material footprint of six areas of consumption in the EU



Notes: The mobility system is partly covered under 'Services' and partly under 'Personal mobility'. The material inputs for the energy and industrial systems are allocated across the six areas of consumption.

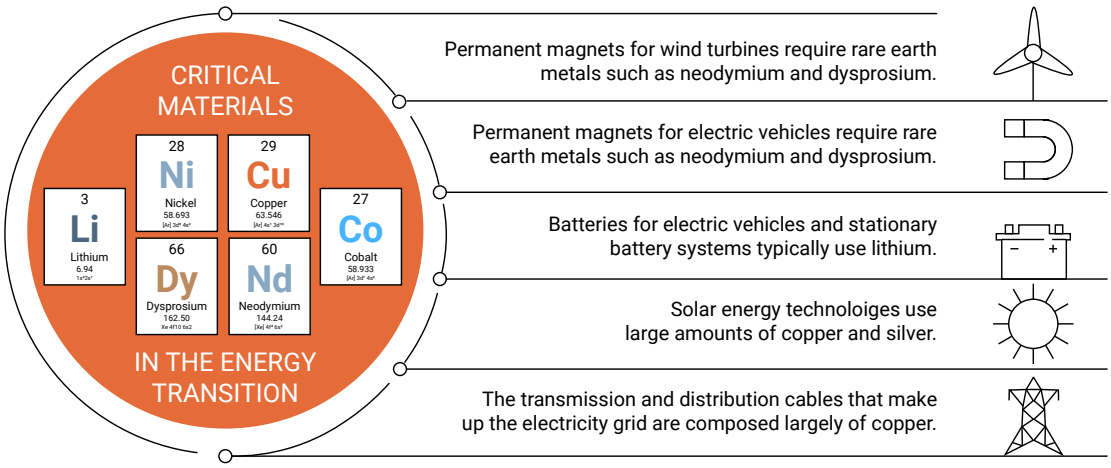
Source: EEA[44].

In the EU energy mix, there is still a heavy dependence on fossil fuels, most of which have to be imported. The need to mitigate climate change and improve the security of the EU's energy supply, including established policy targets for the mobility and energy systems, are leading to a growing demand for a range of critical raw materials up to 2050 (Figure 4.6). These include rare earth metals for wind turbine magnets and BEVs as well as copper and silver for solar energy technologies. The EU expects its demand for rare earth metals to increase six-fold by 2030 and seven-fold by 2050, while demand for lithium is expected to rise 12-fold by 2030 and 20-fold by 2050[45].

There is significant vulnerability along the supply chains for 15 technologies in five strategic sectors of the EU economy: renewables, electric mobility, industry, information and communications technology (ICT), aerospace and defence[46]. The anticipated surge in demand for critical raw materials, for example for use in batteries for electric vehicles, will require comprehensive planning and a strong policy impetus as can be seen in the Clean Industrial Deal.

At the same time, the decarbonisation of the EU's energy, mobility and industrial systems will strongly reduce the demand for fossil fuels that are currently responsible for around one-third of the total environmental footprint related to the EU's material consumption (Figure 4.10). Moreover, the (global) energy transition is likely to substantially reduce the total amount of fossil fuel mining required for the energy system, particularly if the potential for circularity of critical materials are fully achieved[47].

Figure 4.6 **Critical materials in the energy transition**



Source: IRENA[48].

The EU is heavily dependent on imports of critical raw materials from a limited number of countries from outside the EU. For example, 100% of the EU's demand for heavy rare earth elements is imported from China, 79% of its lithium from Chile and 71% of its phosphorus — a key input in the food system — from Kazakhstan. China produces 86% of the world's rare earths and Russia produces 40% of the world's palladium (used in various electronic components and in catalytic converters to reduce vehicle emissions)[43,49,50]. The EU is heavily dependent on China for many

critical raw materials along their whole value chain (e.g. for solar PV). Meanwhile, the EU has become more dependent on imports of fossil fuels with 73% of these imported in 2023[51]; the envisaged energy system transformation would greatly reduce this dependency. These geopolitical dependencies impact the stability and security of supply chains leaving the EU susceptible to supply chain disruptions, as in the case of the most recent gas supply crisis in the context of Russia's war against Ukraine[46].

To reduce the heavy dependence on countries from outside the EU, the Critical Raw Materials Act sets out the aim to be extracting at least 10% of the EU's annual consumption of strategic raw materials domestically by 2030[50]. Production of rare earth minerals in the EU is negligible, though a few projects have begun in Greenland and Sweden. In the short-term, rare earth supplies are expected from Greenland[46]. Moreover, a target is in place to ensure that at least 40% of the EU's annual consumption of raw materials is met by EU processing by 2030. Reshoring production activities will imply trade-offs with biodiversity goals and likely drive pollution, although higher EU environmental standards compared with other international jurisdictions are likely to reduce the overall global impact.

4.2 The case for circularity: progress towards a circular economy in Europe

Why is it important?

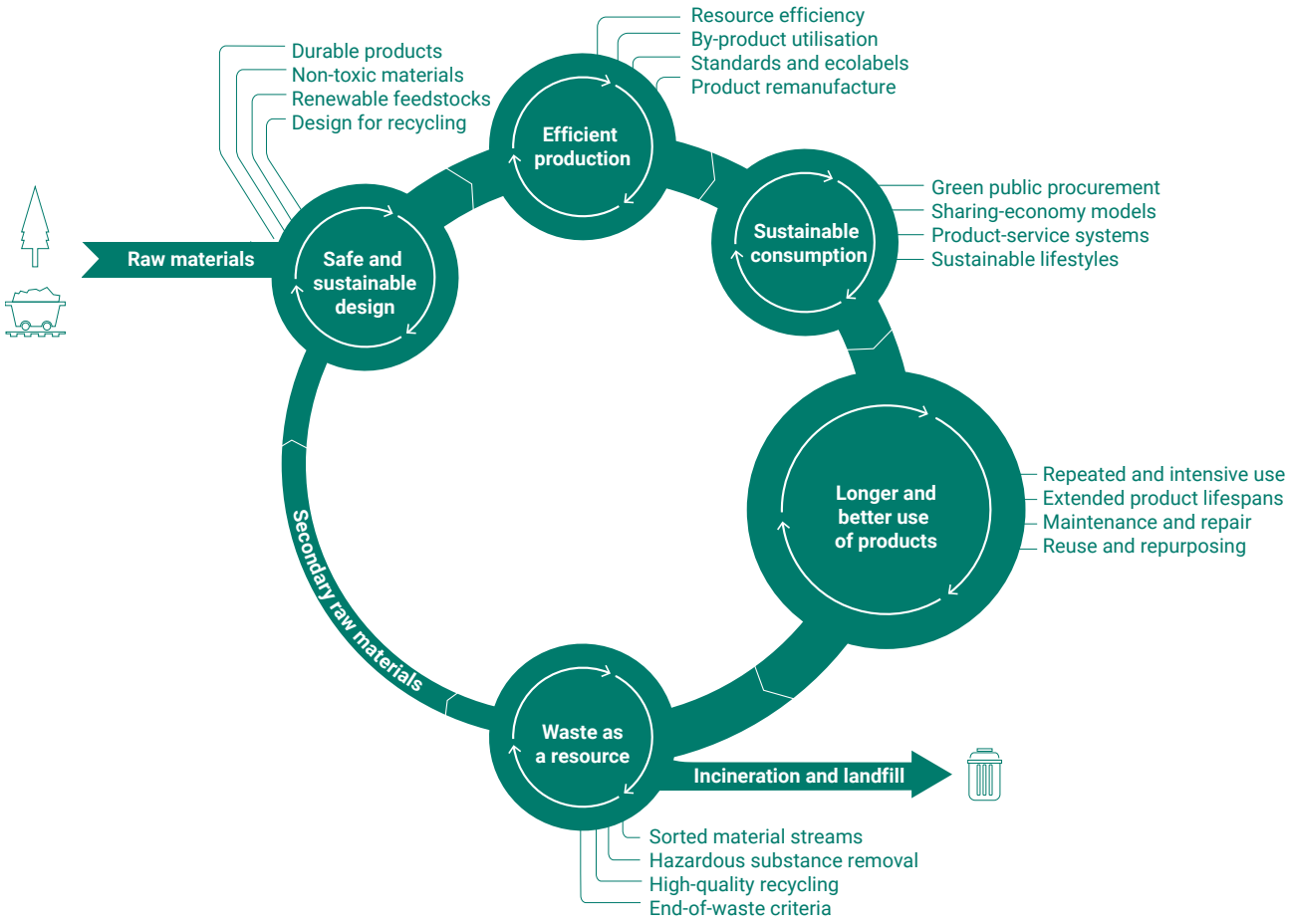
The circular economy is a transformative policy agenda that aims to establish an economy where primary resource use and waste generation are low, thus reducing pressure on our natural resources while reducing the economy's impacts on the environment and climate. This is achieved by keeping the value of products and materials high, making them last longer in their intended use, phasing unnecessary material use out of the economy, and recirculating products and materials for further use[52] (Figure 4.7).

The circular economy offers a means to reduce environmental and climate pressures linked to resource availability and use on the one hand and to properly manage waste on the other. Increasing circularity has the potential to enhance the security of supply of materials used in Europe and increase food security[53]. Its economic effects are also crucial, as it adds to the EU GDP, generates jobs and ensures access to secondary material resources, and ultimately contributes to the EU's strategic autonomy[52,54].

In the EU, consumption levels are high and continue to rise. As a result, there is growing demand for raw materials. While Europe remains heavily reliant on natural resources, a modest decoupling of EU resource consumption from economic growth has been observed since 2010, with total material consumption dropping slightly while EU GDP has increased. Efforts to reduce material resource consumption are spearheaded by the shift towards a circular economy, where products and materials can be used for longer and made into new products after their initial use[52].

Despite these efforts, the global environmental and climate impacts from the consumption of goods and services in Europe are slightly higher today than they were in 2010. Based on the current consumption footprint levels, the EU exceeded its fair share of planetary boundaries for five environmental impact categories in 2022, including particulate matter, climate change and freshwater ecotoxicity[55]. Demands driving the EU's global impacts are housing, food and household goods, which make up more than 70% of total impacts[52].

Figure 4.7 The concept of a circular economy



Source: EEA[52].

European consumption patterns are unsustainable and impacts induced through trade exceed the reductions within Europe, leading to 'leakage' of environmental and climate pressures[56]. Much of the environmental impact tied to European production and consumption occurs beyond Europe's borders.

What is the EU doing?

The EU's Circular Economy Action Plan adopted in 2020 is the main policy document setting out the EU's ambitions and objectives around circular economy. It comprises 35 actions aimed at:

- regulating and increasing the sustainability of products;
- empowering consumers to make more circular choices;
- reducing waste;
- making circularity work at the local and regional levels;
- leading global efforts on circularity; and
- addressing key value chains with high circularity potential.

Following this action plan, key EU laws or their revisions have entered into force or are about to, including the ecodesign for sustainable products regulation (ESPR), the waste framework directive, the batteries regulation and the right to repair directive. Moreover, circular economy principles are adopted and mainstreamed in legislation addressing other policy areas, for example the renovation wave initiative and the construction products regulation (CPR). Most recently, the European Commission (EC) has announced the upcoming Circular Economy Act in its Clean Industrial Deal with the aim of fostering the market for secondary raw materials and increasing the EU's circular material use rate to 24% by 2030. The upcoming Bioeconomy Strategy is intended to reinforce the sustainable and circular use of biomass by setting priorities for manufacturing and using biomaterials and for retaining them for as long as possible in the economy. For example, this could involve applying the cascading use of bio-based materials — prioritising their use for higher-value material applications before considering their use as energy source, and better use of bio-based residues and wastes(57).

The global dimension

Material flows are becoming increasingly global as materials and products are moving along international value chains in a globalised world economy. Therefore, a circular economy needs to be established not only in Europe but also at a global level through the cooperation of all world regions. In this context, the International Resource Panel (IRP) calls for a 'global and national institutionalisation of resource use in sustainability agendas and environmental agreements'(58). Meanwhile, the Clean Industrial Deal calls for clean trade and investment partnerships, including supporting trade partners in deploying investments in decarbonisation and circularity.

Moreover, addressing the unequal allocation of the benefits and costs linked to the use of resources is a critical aspect of ensuring that the green transition is socially fair. Resource use in high-income countries, including EU Member States, is six times higher per person than in low-income countries and regions outside Europe, which already bear part of the burden for the related environmental and climate impacts from this unequal resource use.

Bold policies are necessary but also feasible to reduce EU and global resource use to sustainable levels, make resource use more equitable, and promote best practices and frameworks that enhance social and environmental protection, including in other jurisdictions. There is an urgent need for policies that address both supply and demand for resources, especially in high-income countries(58).

The Clean Industrial Deal and the Circular Economy Action Plan of 2020 recognise the need for global cooperation on circular economy. They outline a set of initiatives towards partnerships and trade agreements that will promote global material circularity.

How is the situation at the European level?

Table 4.1 compiles past trend assessments over the last 10 to 15 years, outlooks for 10 to 15 years ahead, and assessments of the prospects of meeting 2030 and 2050 EU policy targets (where available) from the seven thematic briefings related to circular economy. Details on the assessments are provided in sections 4.2.1 and 4.2.2. Additionally, sections 4.2.3 and 4.2.4 provide information on cross-cutting drivers and pressures related to circularity, and on the interplay between circular economy with biodiversity, climate, and human health.

Table 4.1 Overview of assessment results on circular economy

Briefing	Circular design and sustainable production	Waste generation and material consumption	Waste recycling	Circular use of materials	Circular economy financing and strategies	Benefits of a circular economy	Global impacts from EU consumption
Past trends (10-15 years)							
Outlook (10-15 years)							
Prospects of meeting policy targets for 2030							
Prospects of meeting policy targets for 2050							

Improving trends (are expected to) dominate/largely on track to meet policy targets

Trends (are expected to) show a mixed picture/partially on track to meet targets/highly uncertain

No specific policy targets

Deteriorating trends (are expected to) dominate/largely not on track to meet policy targets

Source: Circular economy briefings of *Europe's environment 2025*.

4.2.1 Past trends

Material consumption within the EU is unsustainable and much higher per person than in most other world regions[58], with each EU citizen using about 14 tonnes of material and generating 5 tonnes of waste annually. As a result, environmental and climate impacts from our consumption already transgress our fair share of planetary boundaries for five out of sixteen environmental impact categories (see briefing 'Global impacts from EU consumption'). There is no sign of a significant reduction in the future.

With a circularity rate of 11.8% in 2023, linear systems of production and consumption prevail in Europe's economy. Nevertheless, a few positive trends in Europe towards a more circular economy have developed over the past 10 to 15 years:

- The share of recycling has been increasing overall and for several waste types, and resource efficiency is improving.
- GHG emissions and air pollution from industry in Europe, as well as their related impacts on climate, human health, the environment and infrastructure, have decreased.
- Investments in the circular economy are increasing, although most of them are still spent on improving waste management.

Unfortunately, most of these trends have been slowing down or stagnating more recently.

Both material use and waste generation have shown no signs of decreasing significantly in the EU, except perhaps in the energy system where renewable sources are increasingly substituting fossil fuels, showing clear synergies between the energy transition and material use (for details see briefings 'Waste generation and material consumption' and 'Trends in the energy system').

At the same time, only 11.8% of all material demand in the EU is sourced from waste, a very small increase from the 10.7% recorded in 2010[60]. This indicates that the EU has not yet transitioned to a low material intensity and a less wasteful circular economy. The country profiles of Europe's environment 2025 provide country-level information on developments in waste generation, circular material use and renewable energy consumption.

In line with stable material use and limited improvements in circularity, environmental and climate impacts related to the EU's material consumption have stagnated or increased, indicating that circular economy measures have not yet succeeded in bending the trend even though they have delivered some jobs and economic growth.

4.2.2 Outlook and prospects for meeting policy targets

The already high and unsustainable levels of material use and waste generation are likely to further increase albeit at a slower pace than the economy. Moreover, there is a risk that increasing consumption will offset some of the material productivity gains. Industrial emissions in Europe as well as consumption of fossil fuels are expected to continue decreasing, due to further decarbonisation efforts and implementation of the revised industrial and livestock rearing emissions directive (IED2.0).

However, positive trends for many air pollutants and emissions to water have levelled off and further improvements will require additional efforts. Driven by recently-adopted policies — which still need to be fully implemented in the coming years — recycling rates are likely to increase but more focus is needed on the quality of recycling and creating well-functioning markets for secondary raw materials. On the other hand, there are no signs that circular business models are scaling up in Europe.

Incremental and technological changes in largely linear systems will not be enough to reap the full environmental and climate benefits of moving to a circular economy and products designed for circularity will not automatically have an extended lifetime or reduce the overall volume of new products used. To foster change, solutions will also have to be strongly targeted at rethinking business models, consumption patterns and governance. While several policies that have been recently adopted or proposed address repair, reuse and reducing waste (especially food waste), they are limited to a few product groups and their impact on demand and consumption patterns remains to be seen.

The Circular Economy Action Plan 2020 calls for the circular use of materials rate to be doubled within a decade. It also states the aim of 'significantly decreasing the Union's material and consumption footprints to bring them into planetary boundaries as soon as possible'. The Zero Pollution Action Plan calls for a significant reduction in waste generation by 2030. These are overarching, non-binding ambitions to guide EU policy and the EU is currently not on track to meet any of these general ambitions. Moreover, many EU Member States are at risk of missing key binding recycling targets even though progress has been made on recycling at the EU level.

The recently-adopted policies on the circularity of certain products, the ESPR and various product-specific directives and regulations have the potential to bring the EU closer to its aim of 'making products fit for a climate-neutral, resource-efficient

and circular economy'; they also have the potential to increase the circular materials use rate and reduce material use, thereby decreasing environment and climate impacts from material production and use. However, their effect will heavily depend on how quickly they are implemented and the ambition level of the requirements for ecodesign developed under the ESPR and other legislation.

Market compliance with the policy requirements will be a key determinant of success that has been deficient in the past. In addition, success will require financial resources. Estimates suggest that investment of at least 21% above the current level will be needed to finance the transition to the circular economy up to 2027 (for details, see briefing 'Circular economy financing and strategies').

Responses and policy gaps

Under the European Green Deal (EGD), the EU has adopted a considerable set of new policies to support a transition towards the circular economy, addressing all phases of products and services — before, during and after use (Figure 4.8).

For the 'before use' product phase, the ESPR has widened the scope of products to be covered by ecodesign requirements; these requirements include circularity aspects such as durability, repairability, upgradability, reusability, recyclability and recycled content ('rethink' in Figure 4.8). In the 2025-2030 period, ecodesign requirements will be developed for textiles/apparel, furniture, mattresses and tyres, as well as intermediate products like iron and steel and aluminium[61].

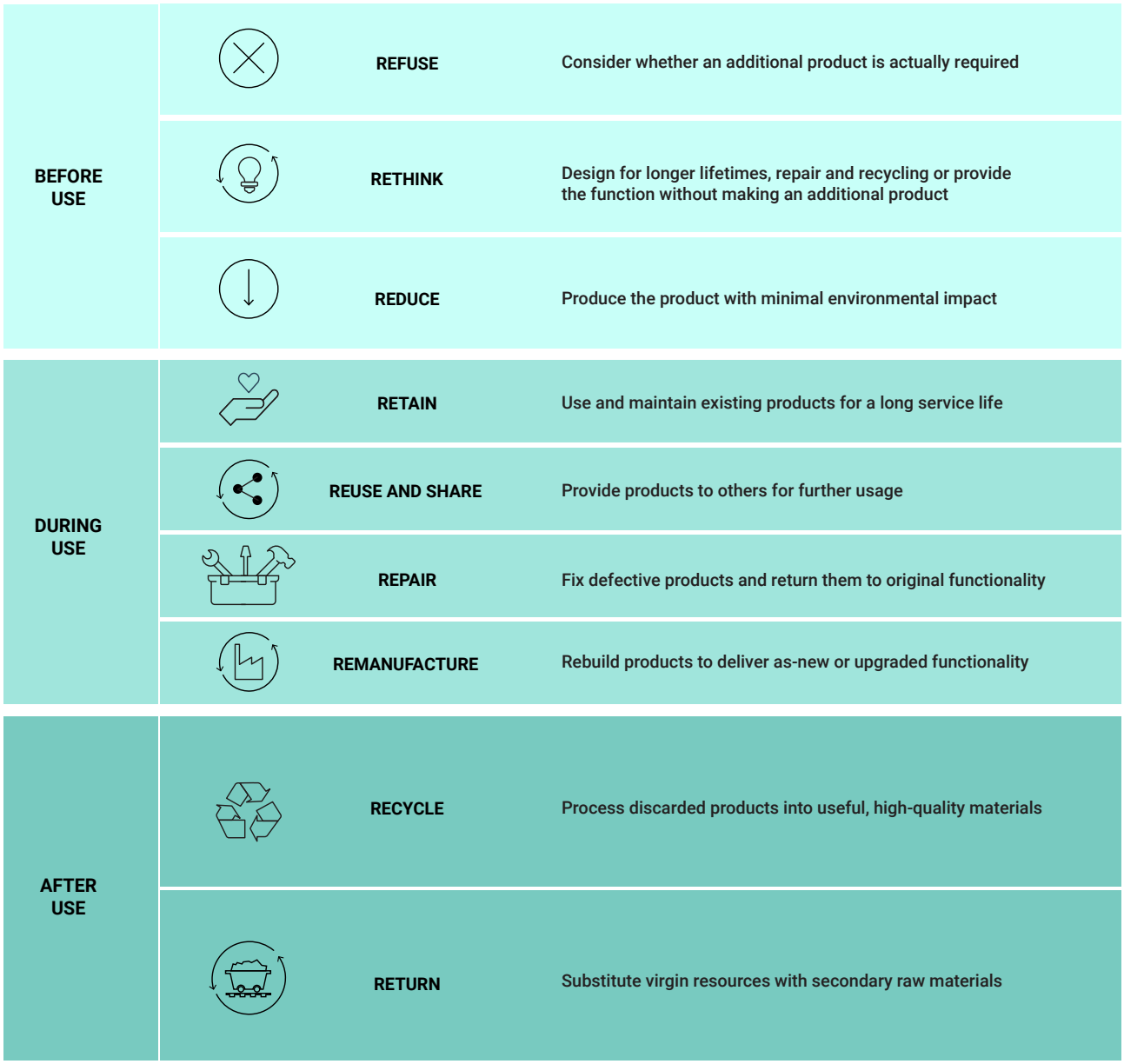
The recently adopted EU batteries regulation and EU packaging and packaging waste regulation, as well as the proposed changes to the waste framework directive (WFD) and the proposed end-of-life vehicles regulation, introduce new circularity requirements, such as recycled content quotas. These will need to be duly implemented and enforced. They include for the first time binding targets on the prevention of food and packaging waste.

In the area of product manufacturing, the IED 2.0 aims to clean up production processes and reduce emissions ('reduce' in Figure 4.8). Sectoral policies addressing product manufacturing, such as the revised EU CPR, also require that circularity aspects such as durability, reparability and recyclability are taken into account when defining technical specifications for construction products allowed on the EU market.

The ESPR and the right to repair directive also address circularity strategies during use, for example in the area of repair. Their implementation will determine if circularity will be adequately promoted while products circulate in the economy, ensuring longer and better use of products ('retain') through reuse, repair, refurbishing and remanufacturing. The proposed green claims directive is expected to support more circular consumption choices by ruling out misleading green claims.

For the 'after product use' phase, the EU has a strong and comprehensive legislative framework in place for promoting better waste management, especially moving from landfill and incineration to recycling. Going forward all stakeholders need to shift the focus towards the quality of recycling and on bolstering secondary raw material markets so that recovered, high-quality materials find their way back into the economy ('return'). Many Member States also need to implement existing waste legislation more effectively.

Figure 4.8 Actions for increased circularity within the product chain



Source: EEA[52].

While the EU has set more than 35 legally-binding targets for the collection and recycling of certain waste streams as well as a few targets for preventing waste (packaging waste, some single-use plastic items, proposed food waste targets), there are no quantified binding targets for resource use, nor are there such targets more broadly for waste prevention or for the circular use of materials. The level of resource consumption is addressed only by a non-binding, directional target aimed at substantially reducing the EU material footprint. However, material resource use is increasingly reflected in national circular economy strategies (Box 4.7).

Box 4.7

National targets on material resource use

The International Resource Panel (IRP) finds that without urgent and concerted action to change the way resources are used, material resource extraction could increase by almost 60% from 2020 levels by 2060 (58). Against this backdrop, some countries are taking action to reduce material resource use.

Germany's national circular economy strategy takes the objective of reducing annual per capita material resource use to 6–8 tonnes by 2050 as a guiding principle. This principle supports goals such as closing material cycles, securing raw material supply and reducing primary resource consumption. Austria's strategy, adopted in 2022, sets targets of reducing domestic material consumption to 14 tonnes per capita by 2030 and lowering the material footprint to 7 tonnes by 2050. In Belgium, the Flemish region aims to cut its material footprint by 30% by 2030, while the Walloon region targets a 25% reduction in direct material demand and domestic consumption compared to 2013.

Countries are also setting targets for the circularity rate (technically referred to as circular material use rate — CMUR), which measures the share of materials sourced from waste. The EU's non-binding goal is to increase the EU's CMUR to 24% by 2030. CMUR can be improved by increasing recycling, reducing virgin material use or both. Estonia targets a 30% CMUR by 2035; Finland aims to double its rate by 2035 compared to 2015; Ireland seeks to reach the EU average; Latvia targets 11% by 2027. Germany and Austria also align with the EU's ambition, with Austria aiming for 18% by 2030.

Achieving these targets will require not only improved recycling but also significant reductions in overall resource use. National strategies increasingly reflect this dual approach, combining material efficiency with circularity to support sustainable development and resource security.

Reducing the unsustainable levels of resource consumption — for example, through the introduction of resource use targets — would boost circularity and mitigate climate, biodiversity and pollution impacts linked to resource extraction and processing. Policymaking for resource use — that takes into account global resilience with respect to planetary boundaries — could focus on introducing measures with the highest potential for environmental benefits and foster circularity for key (including critical) raw materials, addressing concerns regarding the security of supply. Robust and responsive monitoring frameworks are needed to monitor progress towards reduced resource use and enable flexibility in response to technological developments(52).

More specifically, innovative instruments — such as recycled content targets, application of economic incentives in extended producer responsibility schemes, the introduction of digital product passports and the right to repair directive — have recently been introduced for selected product groups but still need to be resourced and implemented on the ground. Extended producer responsibility is used for an increasing number of products both in the EU and at the national level(52).

The new and still to be developed circularity minimum requirements for a large range of products should enable higher durability, repairability, recyclability and opportunity for remanufacturing. However, this does not automatically lead to products being used for longer, repaired, recycled or remanufactured. Policies are also needed to foster and enable circular business models and consumption patterns that embrace these opportunities. At the same time, policies must also help avoid a scenario in which spending is simply redirected to other areas with a high environmental footprint. Meanwhile, the forthcoming Bioeconomy Strategy has the potential to promote bio-based materials in such a way that demand for fossil-based materials is reduced and resource autonomy is reinforced in the EU (Box 4.8).

Box 4.8

The bioeconomy

The bioeconomy includes biomass production, biomass conversion into food, materials and products, and bioenergy. In 2021, the biomass-producing and converting sectors of the EU economy generated EUR 728 billion of value added and employed 17.2 million people; this represents 5% of EU GDP and 8.2% of employment(62).

Biomass production depends on the sustainable and regenerative use of nature. It is therefore crucial that it is produced and extracted in a manner that is energy- and materially efficient and follows the principles of circularity(63). Boosting the bioeconomy has the potential to promote business models that foster the regeneration of ecosystem services as means of securing supply.

Shaping the future of Europe's bioeconomy provides an opportunity to ensure coherence across policies dealing with ecosystem management and restoration, circularity as well as biomass extraction and use for food, material and energy(64).

The new Bioeconomy Strategy, foreseen for late 2025, aims to make EU businesses more competitive and increase green jobs without damaging nature. It will be aimed at European farmers, foresters, industry and businesses, particularly small-medium enterprises (SMEs) and startups in rural and coastal areas. The main goals of the strategy are:

- to ensure the long-term competitiveness of the EU bioeconomy and investment security;
- to increase the resource-efficient and circular use of biological resources;
- to secure the competitive and sustainable supply of biomass, both domestically and from outside the EU;
- to position the EU in the rapidly expanding international market for bio-based materials, biomanufacturing, biochemicals and the agri-food and biotech sectors(57).

The combined impact of all these new policies on Europe's material consumption and circularity remains to be seen. Reaping their potential benefits will require them to be implemented swiftly and thoroughly both at EU and national levels. For example, the ESPR and CPR are framework legislation that define general principles for ecodesign. More specific ecodesign requirements for the product groups in their scope then have to be defined separately in delegated acts which require considerable resources from both public institutions and private stakeholders in the coming years. Additionally, the finance gap needs to be closed (see details in the briefing 'Circular economy financing and strategy'). Risks posed during the implementation of such policies need to be tackled, for example rebound effects as a result of resource efficiency policies. Rebound effects refer to increased resource consumption (a first-order rebound effect) or additional consumption in other parts of the economy (a second-order rebound effect) due to cost savings achieved by resource efficiency measures; these need to be avoided(65).

Instruments such as green and circular public and private procurement still have significant potential (as recognised in the recent Clean Industrial Deal). Additionally, measures that will shape consumer behaviour, such as fiscal policies and awareness-raising, are needed; these would boost acceptance of circular solutions, and bring down prices for businesses and consumers. More broadly, EU policies on material sourcing could foster circular economy principles more effectively by increasing the number of materials targeted beyond those covered by the Critical Raw Materials Act.

The EU single market also has a role to play in fostering demand for secondary materials and creating a single market for waste, thus reducing dependencies for resources. The Competitiveness Compass responds to all these concerns. For example, the forthcoming Circular Economy Act aims to catalyse investment in recycling capacity and encourage EU industry use secondary materials instead of virgin ones, as well as reduce the waste that is incinerated or goes to landfill. It also foresees the creation of a single market for waste, secondary and reusable materials, to promote reuse and recycling[66].

Finally, circular economy policies usually prioritise technological and economic solutions, often neglecting social dimensions such as impacts on employment, informal labour and gender inequality[67]. A just circular economy must be actively shaped, requiring intentional and well-designed processes to avoid perpetuating existing inequalities and creating new ones. Tailored approaches focused on distributional, procedural and recognitional justice are required to address justice concerns within global value chains — like poor labour conditions, health risks and unequal economic benefits[68].

Lastly, Europe alone cannot curb unsustainable resource use at the planetary scale. Therefore, a robust global governance framework on resource use and circular economy is essential.

4.2.3 Drivers and pressures

The current systems of production and consumption in Europe are still largely linear, with a high throughput of short-lived products placed on the market. Mass production-based value chains and linear business models dominate the market, and the quality of products is often compromised[52]. This economic model only persists because the cost to the environment and climate are not accounted for, and because products and materials are imported from countries with much lower labour costs or less stringent environmental restrictions compared to Europe. It is also fostered, in part, by aggressive marketing strategies creating constantly new demand and driving up overconsumption and a wasteful use of material resources.

The current economic system creates demand for very high material use in the EU. The total material footprint of the EU stood at more than 6.3 billion tonnes in 2023, translating into more than 14 tonnes per capita in a single year, which is higher than most other world regions[44]. As discussed earlier, housing, food and mobility together account for more than 80% of the total material footprint (Figure 4.5).

Waste generation in the EU is also very high at 5 tonnes of waste generated per person in 2022 or 2.2 billion tonnes in total[69]. The construction and mining sectors together are responsible for 61% of all the waste generated (Figure 4.9) but the types of waste these activities produce are mostly less environmentally relevant than wastes from most other activities.

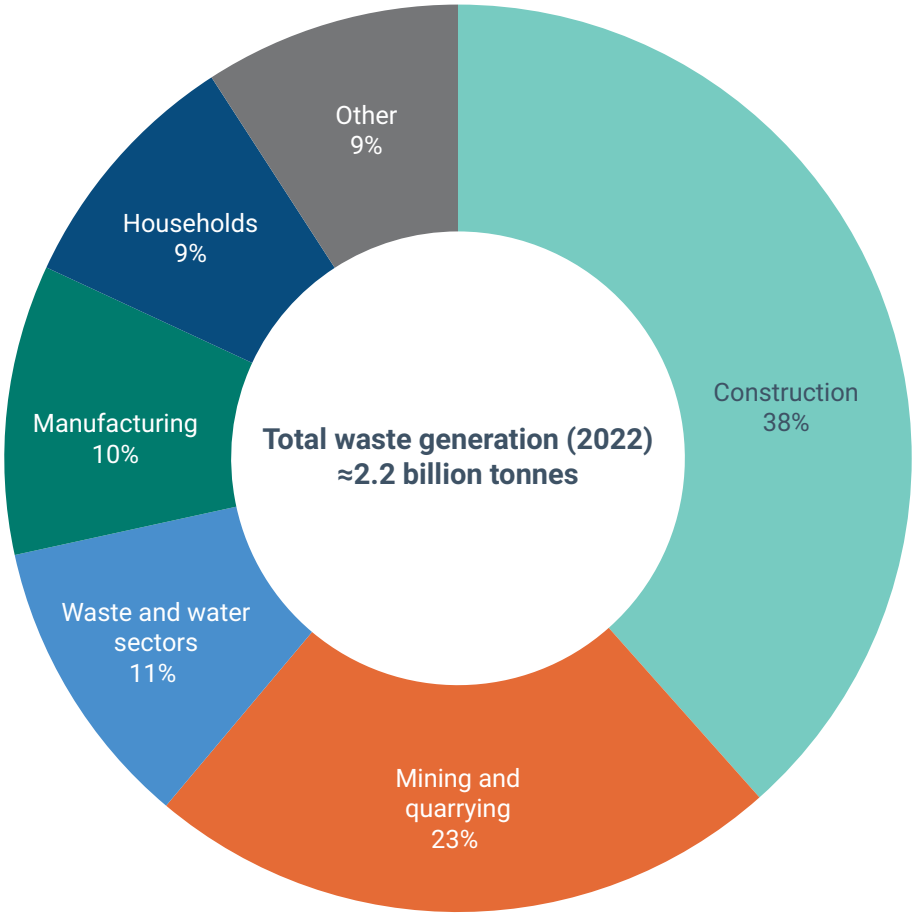
The high levels of waste generation in the EU indicate that the current economic system is very wasteful, as illustrated by current practices in specific sectors of the economy. For example, an estimated 4-9% of all textile products put on the market in Europe are destroyed before use, around 20% of garments sold online are returned and on average, one-third of all returned clothing bought online ends up being destroyed[70].

Furthermore, it is estimated that around 10% of all food supplied to EU consumers ended up as loss or waste in 2022 and each EU resident is responsible for 132 kilograms (kg) of food waste annually[71]. An additional example is the high

levels of plastics consumption and plastic waste generation; these are expected to continue to grow, generating extensive environmental and health impacts, from marine litter to microplastics emissions and high levels of GHG emissions along the whole plastics value chain[72].

The EU's flow of materials has been relatively stable in recent years, as both the consumption of raw materials and the total waste generated show little variation over time, although the economy has been growing. This modest decoupling of resource flows from economic growth is a positive development; however, the level of pressure from both significant raw material consumption and waste generation are very high and cause irreparable damage to our environment and climate.

Figure 4.9 **Waste generation by sector in the EU-27 in 2022**



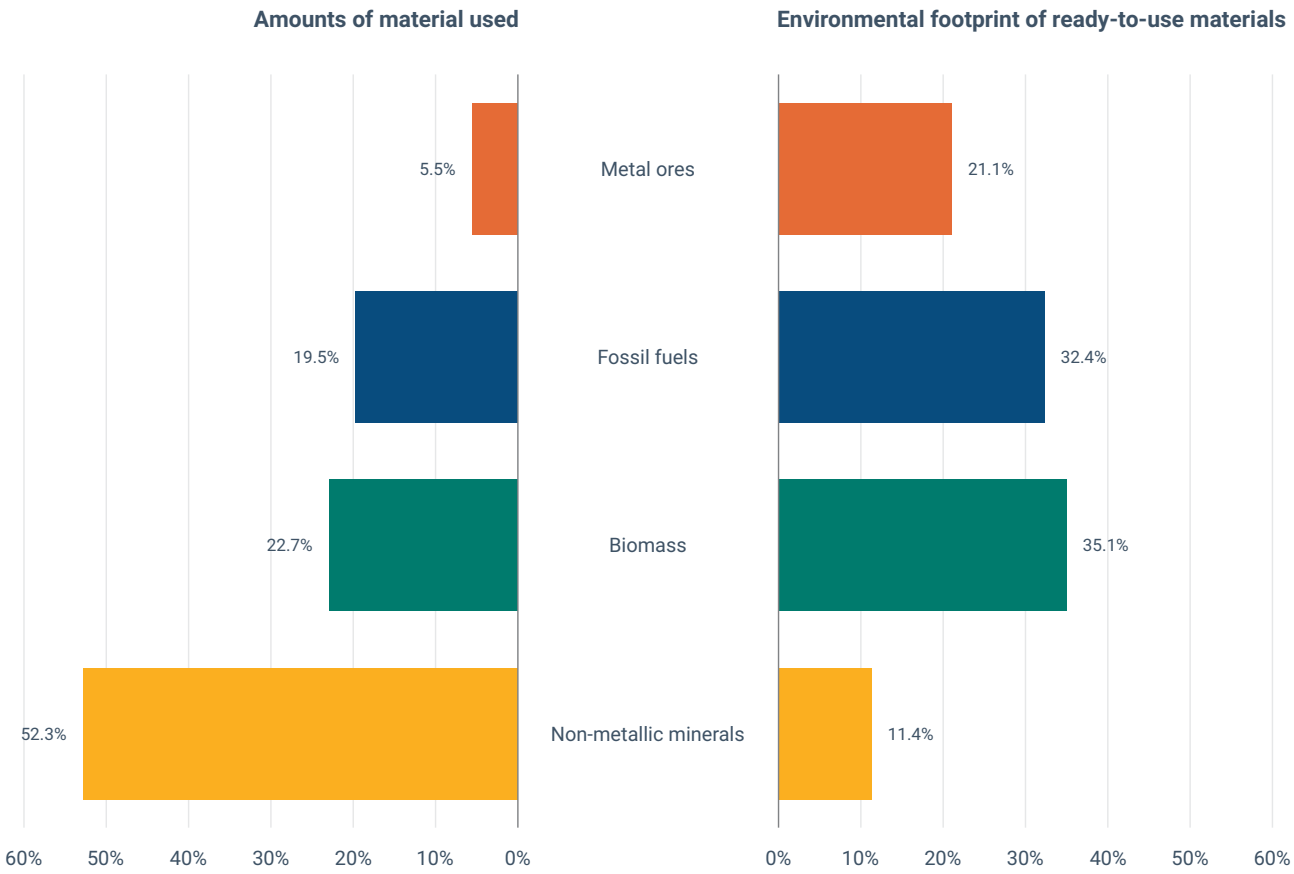
Source: EEA based on Eurostat[69].

Globally, more than half of GHG emissions, 40% of health-related impacts due to particulate matter and more than 90% of biodiversity loss and water stress come from resource extraction and processing[58]. The EU, home to 5.5% of the global population, consumed 6.7% of resources extracted globally in 2020 (calculated as the material footprint for the year divided by the global extraction of materials)[58] and was responsible for 8.7% of the total global climate impacts associated with resource extraction and processing in 2021[73]. Similarly, EU consumption drives 7.2% of global land-based biodiversity loss and 7.1% of health impacts due to emissions of particulate matter from resource extraction and processing[58,73,74]. The systems mostly contributing to these global impacts are housing, food, household goods and personal mobility[75].

However, not all resource consumption has the same impacts on the environment and climate. The extraction and processing of metals is more impactful than that for non-metallic minerals like sand and gravel. Figure 4.10 shows that although the raw material consumption profile of the EU is dominated by non-metallic minerals in terms of mass, when looking at the environmental pressures linked to material consumption, the fossil fuels and biomass material categories are more relevant.

Resource efficiency gains, which reduce the material needs per unit of energy produced, and in particular the shift away from fossil fuels to renewable energy sources[76] (see briefing 'Trends in the energy system' for details), have so far managed to contain the rising demand for raw materials in a growing EU economy[44]. Consequently, the environmental and climate pressures linked to resource extraction and processing have more or less stabilised (see also briefing 'Global impacts from EU consumption'. However, available projections[77] show that the demand for raw materials is likely to keep increasing in Europe. This, in combination with the fact that resource consumption and waste generation are already too high in the EU, means that a more circular economy is needed urgently.

Figure 4.10 **Volumes of materials used against the environmental footprint of these materials in the EU-27 in 2022**



Source: ETC CE[73].

Mitigating the impacts of resource use in Europe is possible only by reducing reliance on the extraction of natural resources. This can be achieved either by addressing the high levels of resource consumption directly or by replacing virgin resources with secondary materials.

In the past, the EU has achieved a substantial improvement in the management of its waste by increasing recycling[78]. However, research shows that substantial reductions in resource use and related environmental impacts cannot be achieved by recycling alone[79]. This is because the economy uses many more materials than it generates as waste because fuels are burnt and materials stay for a long time in buildings and infrastructure. Additionally, recycling is limited because quality and materials are lost in the process along the recycling value chain. In spite of this, there is still significant potential for returning much higher amounts of waste back into the economy as secondary resources.

4.2.4 Circular economy and biodiversity, climate and human health

The circular economy has significant potential to reduce pressures on biodiversity, climate, soil degradation and pollution. This can be achieved primarily by lowering the volume of resources used within the economy and, to a lesser extent, by reducing waste and the environmental pressures from waste management activities.

Reducing the need for virgin materials including bio-based materials and freshwater, as well as biodiversity-friendly sourcing through circular economy practices, would lead to reduced resource extraction, less need for land and water, and lower emissions. This would reduce pressures on biodiversity indirectly by mitigating factors like habitat destruction[80]. For example, by improving the efficiency of material use, there would be less need for raw wood harvesting, which would benefit forest ecosystems. However, it is important to be alert to rebound effects, where increased overall supply might offset these environmental gains[52]. Greater circular use of nutrients and water is also essential for improving the health of aquatic ecosystems.

Biodiversity-friendly sourcing practices — such as improving forestry management and encouraging the regeneration of natural habitats through methods like extensive grazing and agroforestry — are vital for minimising the negative impacts of resource extraction.

Circular economy initiatives can play a crucial role in reducing material demand. In turn, this would reduce the energy needed for production and processing, thereby lowering related environmental pressures. Using secondary raw materials instead of virgin materials would in most cases reduce the environmental pressures from production. While the waste management sector itself produces GHG emissions, waste policies have significantly curbed these emissions; the waste sector's emissions in European countries have decreased by 42% since 1990[81]. As an example of progress at the Member States level, Slovenia has made use of economic instruments to reduce emissions from the waste sector (Box 4.9).

Box 4.9

Greenhouse gas emission reductions through smart waste management in Slovenia

Slovenia is steadily moving toward sustainable waste management. The country exemplifies how targeted policies and integrated systems can reduce environmental impacts while supporting the EU's climate and circular economy goals. While total waste generation in Slovenia has increased over the last decade, primarily due to soil, construction and demolition waste, the country is on track to meet its 2025 recycling targets for municipal and packaging waste, and its 2035 landfill target.

Slovenia's municipal waste recycling rate reached 59.8% in 2023, higher than the EU average of 48.2%[82]. Municipal waste landfilling has declined, reaching just 9.3% in 2023[83]. This achievement is partially due to policies such as a landfill ban on biodegradable waste, a landfill tax, and waste fees that encourage the whole population to sort their waste. This waste fee system has promoted more responsible waste separation at the source.

Packaging waste has risen, reaching 142 kg per capita in 2022[84], but remains well below the EU average. Slovenia's packaging waste recycling rate reached 62.6% in 2022[85], driven by improvements in data quality and collection systems. Door-to-door collection, combined with collection points and civic amenity sites, makes recycling accessible across the country.

Slovenia's 2022 National Waste Management Plan and Waste Prevention Programme prioritises circularity, reuse and public engagement. Initiatives focus on reusing textiles, electronics and bulky waste, as well as campaigns to reduce food waste in households and the public sector. While challenges remain, such as improving fee modulation for extended producer responsibility and increasing reuse infrastructure, Slovenia remains committed to reducing and preventing waste (see Slovenia's country profile).

With a firm legislative foundation and broad buy-in from its citizens, Slovenia demonstrates how ambitious yet practical waste management strategies can help meet both national and EU environmental goals[86,87,88].

Most production sectors and consumer activities generate waste, which can lead to water, soil and air pollution, particularly when waste is managed improperly. For example, per- and polyfluoroalkyl substances (PFAS) in textiles contribute to environmental pollution[89]. Circular economy practices can help reduce the demand for raw materials; in turn, this decreases emissions and pollution from resource extraction and processing.

Additionally, designing and producing products with minimal harmful substances (following the safe and sustainable by design approach) reduces the risk of emissions and negative health impacts during the production, use and end-of-life stages, facilitating cleaner material cycles.

However, if harmful chemicals are incorporated into products before regulation, they can hinder reuse, recycling and extended product lifespans as well as pose health risks[90]. While waste management processes such as landfilling, incineration and recycling can generate pollutants, they can also play a role in removing harmful substances from the economy by either destroying them or storing them in safe places.

Finally, knowledge gaps still exist regarding the impacts of climate change on the circular economy. For example, climate-related disasters may generate large amounts of waste or destabilise landfills, and climate adaptation measures could require substantial material inputs.

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5 Delivering on people's needs: Europe's production and consumption systems

Key messages

- All Member States have successfully made progress in shifting away from fossil fuels towards more sustainable energy sources over the last decade. Increased energy efficiency has also brought down demand. Nevertheless, fossil fuels remain the dominant source of energy, making up almost 70% of EU gross available energy use (the quantity of energy necessary to satisfy all energy demands) in 2023.

- The mobility system in Europe continues to be dominated by vehicular transport, with passenger cars responsible for more than 75% of transport activity in Europe. It is also still heavily dependent on fossil fuels. While air pollution from the transport sector has fallen, 30% of the EU population lives in areas where transport noise reaches levels that harm health. Maritime transport and aviation are both responsible for significant environmental pressures, with international aviation in particular producing significantly higher emissions over the last decades.

- Greenhouse gas emissions from industry fell by more than 35% from 2005 to 2023. Further decarbonisation will require both large-scale electrification, a switch to hydrogen for certain industrial processes and the substitution of fossil fuel-based raw materials with renewables. Decreased air pollution from industry has been an important co-benefit of decarbonisation measures. To achieve further gains, circularity measures offer promising synergies between decarbonisation, zero pollution and resource efficiency.

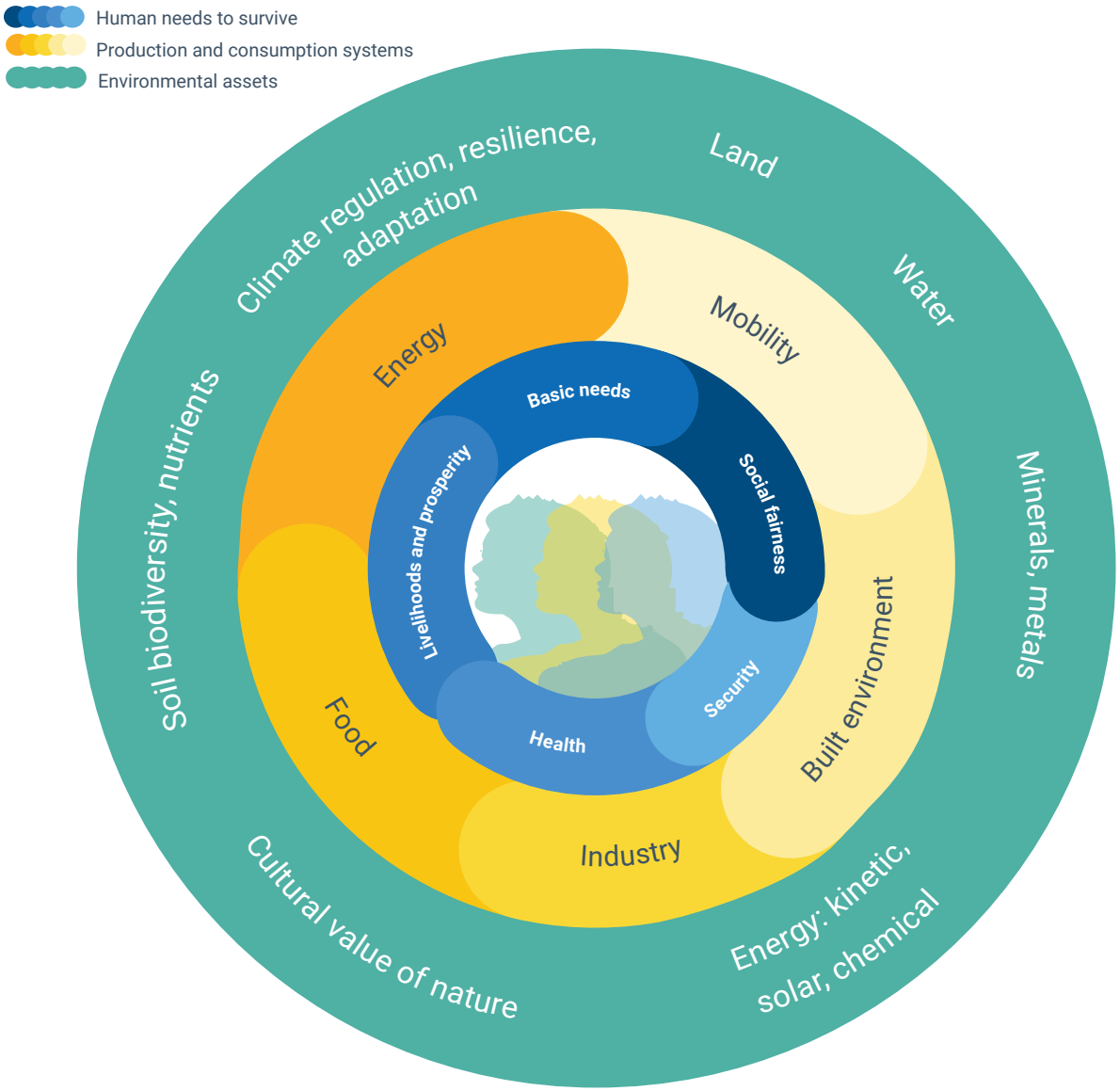
- Food systems are a primary driver of ecosystem degradation. Despite some progress in production practices — such as the increased area dedicated to organic farming, biodiversity decline has not been halted, pressure on water availability has increased, and there has been no significant reduction in GHG emissions. This underlines the urgent need for systemic transformation of Europe's food system.

- GHG emissions from EU buildings decreased by more than 35% between 2005 and 2023. This was driven by higher energy efficiency standards for new buildings and decarbonising the electricity and heating sectors. Energy-efficient renovation that addresses rebound effects (when increased energy efficiency in buildings leads to increased energy consumption due to behavioural changes), climate-resilient buildings and adopting circular economy models will be required to make the EU building stock fit to meet the EU's 2050 goals.

Introduction

This chapter outlines the relationship between Europe's key production and consumption systems — energy, mobility, industry, food and the built environment — both in terms of their dependence on natural resources and, conversely, their impacts on the environment and climate. Europe's natural resources are vital to these systems, with land, water and raw materials underpinning Europe's economic development and prosperity (Figure 5.1). At the same time, these systems cumulatively drive climate and environmental pressures and impacts — both in Europe and globally. They undermine the very resource base upon which they depend[1,2,3].

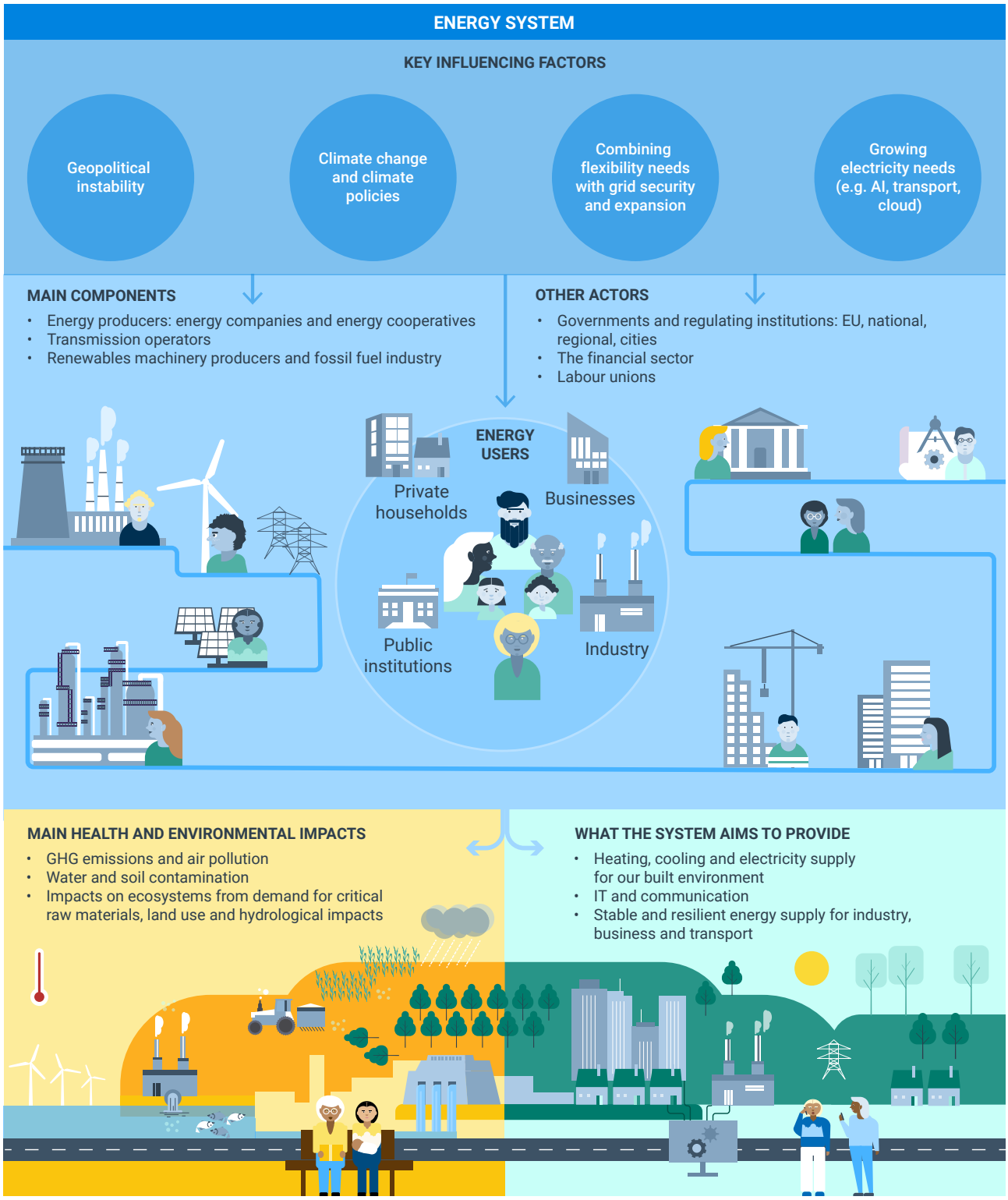
Figure 5.1 **Why the natural environment is key to human health and prosperity**



Source: EEA, 2025.

5.1 Energy system

Figure 5.2 The energy system



Source: EEA, 2025.

5.1.1 Systems-level EU policies

The European Climate Law sets binding targets to reduce net GHG emissions by 55% by 2030 compared to 1990 levels and net-zero by 2050. The Fit for 55 policy package addresses all sectors to meet this target. The REPowerEU plan aims to increase the share of renewables in the energy mix in response to the recent energy crisis. It targets a minimum 42.5% share of renewables in EU energy consumption by 2030, with the ambition to reach 45%. The energy performance of buildings directive and the renovation wave address energy inefficiencies in the built environment, while other EU frameworks aim to increase energy efficiency and circularity in energy-consuming products.

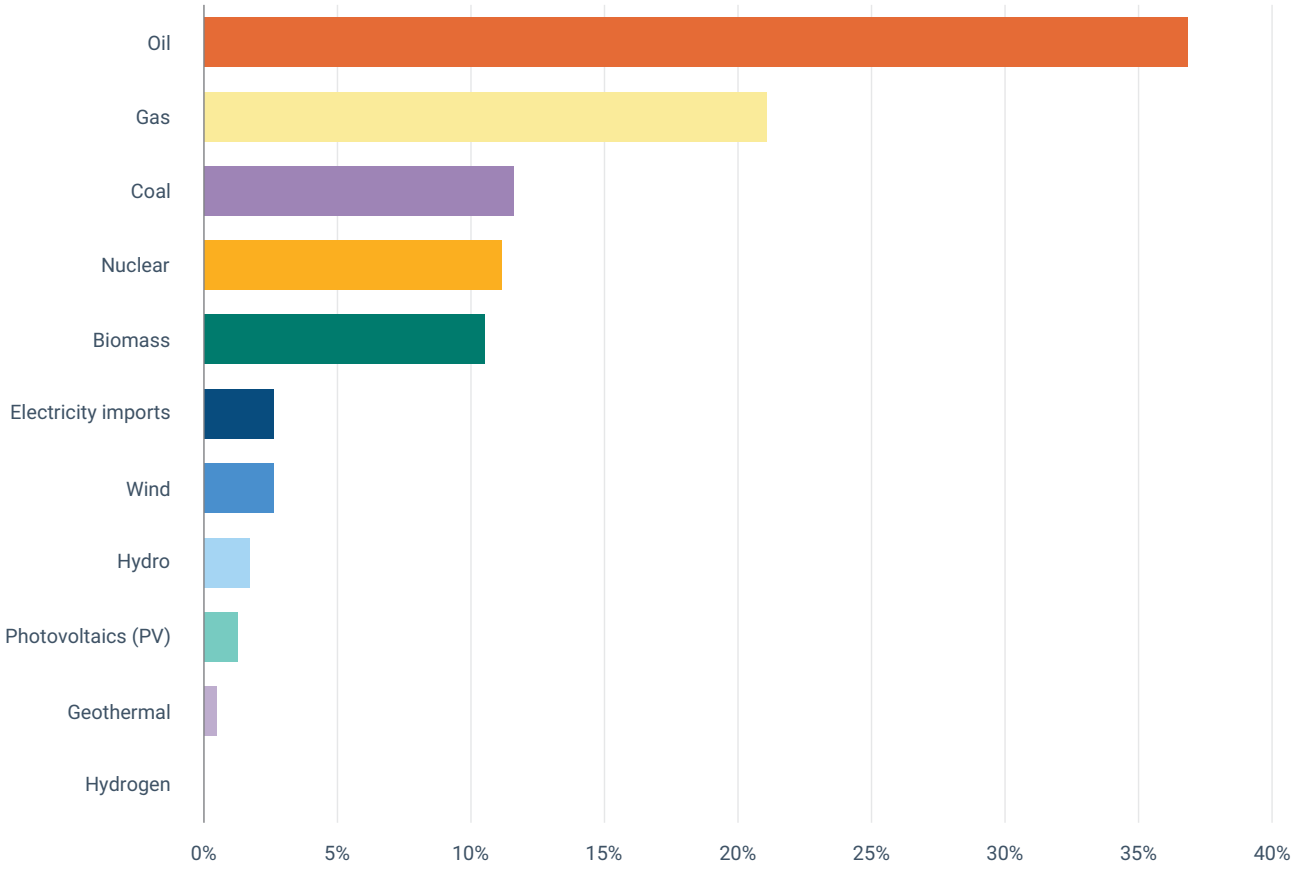
Such frameworks include the industrial and livestock rearing emissions directive, which aims to control the emissions of air pollutants from large industrial and livestock installations. The Clean Industrial Deal (CID) recognises energy pricing and energy security as key for both the EU's competitiveness and decarbonisation. It includes many actions to bring energy prices down and to create markets for clean technologies. One result is the Affordable Energy Action Plan, which sets specific measures for secure and affordable energy. The CID, alongside policies to reduce GHG and emissions from mobility, and the revised EU rules for gas and electricity markets and for batteries, are strongly impacting the energy system. The EU Emissions Trading System (ETS) is the EU climate policy's key tool to reduce GHG emissions cost-effectively. It is the world's first carbon market, remains among the largest globally and was recently extended to include maritime transport(4).

5.1.2 Progress and challenges

The disruption of the energy market associated with Russia's war against Ukraine has further propelled the transformation agenda in the EU's energy system. It involves the twin objectives of cutting dependency on Russian fossil fuels and decarbonisation to reach climate goals.

Nevertheless, fossil fuels remain the dominant source of energy in the EU's energy system. In 2023, fossil fuels made up almost 70% of the EU's gross available energy use (see Figure 5.3). As well as driving GHG emissions, the conversion of energy to electricity and heat entails significant waste. Oil (37% of the EU's gross available energy use) is primarily burned in transport, while gas (21%) and coal (13%) are used to produce electricity and heating. Notably, in 2022, 98% of all oil and all gas used in the EU was imported, reflecting dependencies and posing risks of supply shortages for the EU economy. This situation also hampers the EU's competitiveness due to high energy prices. Renewable energy sources and nuclear energy meet 16% and 11% of the EU's electricity and heating needs, respectively(5).

Figure 5.3 **Gross available energy in the EU by energy carrier in 2022**



Source: EEA[5].

Despite this ongoing dependence on fossil fuels, the energy sector has made significant progress with emission reductions. The energy supply sector recorded an estimated 19% reduction in GHG emissions from 2022 to 2023, driven by the roll-out of renewable energy production as well as a limited decrease in electricity production. As of 2023, the energy supply sector had reduced its emissions by almost 50% compared with 2005 levels, with the energy supply system contributing 26% of total EU GHG emissions in 2023[6].

In sharp contrast to the other systems considered here, the energy system shows a trend of reduced demand due to successful measures to promote energy efficiency. Primary energy consumption (PEC) in the EU — defined as the total energy demand, excluding the energy consumed for purposes other than producing useful energy (e.g. oil for plastics) — by end users fell by 19.2% in 2023 compared to 2005. Meanwhile, final energy consumption (FEC) — defined as the energy used by final consumers (such as households, transport, industry, etc.) for all energy uses — fell by 12.1%, with the highest falls seen in the past three years[7].

Notably, the replacement of fossil fuels and nuclear energy by renewables in electricity generation typically reduces the PEC without affecting the FEC. The rate of reduction observed in both PEC and FEC over the past three years suggests that the 2030 energy efficiency targets could be achieved, provided that the observed rate of reduction persists through to the end of this decade[7,8].

As a means of reducing demand, the 'energy efficiency first' principle in the EU's policy framework is defined as:

> […] taking utmost account in energy planning, and in policy and investment decisions, of alternative cost-efficient energy efficiency measures to make energy demand and energy supply more efficient, in particular by means of cost-effective end-use energy savings, demand response initiatives and more efficient conversion, transmission and distribution of energy, whilst still achieving the objectives of those decisions[9].

In 2023, renewable energy sources represented 24.5% of the EU's FEC, a historical high driven by EU policies to speed up the clean energy transition, including the Fit for 55 EU policy package and the REPowerEU plan. In order to meet the new minimum EU target of 42.5% for 2030 the rates of renewables deployment seen over the past decade will need to be doubled and there will need to be an extensive transformation of the European energy system[10]. A good example of the progress made in shifting from fossil fuels to renewables is Portugal and is presented in Box 5.1.

Box 5.1

Portugal: a leading example of decarbonisation in action

Portugal is decarbonising its economy through its national energy and climate plan (running up to 2030) and aims to achieve climate neutrality by 2045. The country has nearly doubled the share of renewables in its final energy consumption, from 19% in 2004 to 35% in 2023[11].

Renewables supplied over 73% of Portugal's electricity mix in 2023, positioning the country as one of the front-runners in Europe's energy transition. This shift has been driven by the expansion of hydropower, wind and solar energy. Portugal invested heavily in additional hydropower and in wind power since the early 2000s. In recent years, it rapidly scaled up solar capacity through large-scale photovoltaic projects and by increasingly adopting rooftop solar installations. The country also invested in upgrading dammed hydropower plants with reverse pumping, providing storage and enhancing security of supply.

The 2021 closure of coal-fired power plants marked a pivotal step in reducing emissions and sent a clear signal about the country's commitment to fossil fuel phase-out.
See Portugal's country profile for more details.

Progress in the electricity subsystem over the past two decades has been remarkable, both in terms of the generation of renewables and reducing GHG emissions[12]. This has been enabled by several factors:

- significant policy initiatives and legislation;
- the falling costs of solar and wind power technologies; and
- structural economic change.

GHG emissions from European power and industry plants have decreased by approximately 47% compared to 2005 levels[13]. In parallel, the share of electricity from renewable energy sources (RES) has grown from 15% to over 45% between 2000 and 2023, which makes the EU the world region with the highest electricity share from renewable energy sources[14].

As a leader in the deployment of renewable energy, Denmark is a success story in decarbonising electricity production (See Box 5.2).

Box 5.2

Denmark's path to a decarbonised power sector

Denmark has emerged as a frontrunner in the transition to a fully decarbonised electricity sector thanks to political leadership and strategic investment. Denmark offers a compelling example of how a country can shift from fossil fuels to clean energy while continuing to ensure economic growth and energy security.

Since 1990, Denmark has cut its energy-related CO_2 emissions by more than 50%, demonstrating that meaningful, systemic change is possible when governments, industry and society align around ambitious climate goals. By 2023, renewable sources accounted for 82% of Denmark's electricity, among the highest shares globally. Wind power alone met 53.8% of electricity demand, the result of Denmark's leadership in wind energy innovation and deployment.

Denmark's energy mix is also characterized by diversity. In addition to wind, biomass contributed 16.4%, solar 9.3% and biogas 2.5%, creating a balanced and resilient energy system. At the same time, the country has made rapid strides in phasing out fossil fuels. Between 2022 and 2023, coal use dropped by 31% as part of a broader, sustained strategy to eliminate carbon-intensive fuels altogether. This transition not only reduces emissions but also protects the Danish economy from the volatility of global energy markets.

Looking forward, Denmark has set ambitious and legally-binding climate targets. These include a 70% reduction in GHG emissions by 2030 compared to 1990, as mandated by the 2020 Climate Act. See Denmark's country profile for more details.

Decarbonisation of the other two subsystems in the energy system, heating and transport, has been significantly slower overall than for electrification — the process of converting energy systems to use electricity as the primary power source. Decarbonising these subsystems is complex for technological as well as societal reasons and due to the strong reliance on natural gas for heating (mainly in buildings and industry) and on oil for transport. As such, progress in these areas has been limited to date.

In heating, there was a gradual move from gas to biomass and increasingly to heat pumps, with modest energy efficiency gains in buildings. As of 2023, 26.2% of heating and cooling energy needs in the EU were provided by renewables[14]. A stronger focus on the two-pronged strategy — to boost the thermal efficiency of buildings and phase out fossil heating systems — is necessary[5].

Renewable electricity consumption in road transport increased notably between 2022 and 2023 (+53%). The target for all new cars and vans to be zero-emission by 2035 is a concrete commitment towards decarbonisation.

Not all developments have been in favour of electrification though. The past four years have seen a record expansion in the EU of liquid natural gas (LNG) terminals to receive more gas, although those are likely to become stranded assets — become obsolete or non-productive before the end of their anticipated lifespan — due to progress towards the energy transition[15]. Fossil fuel subsidies reached their highest levels ever in 2022 and 2023[16], while subsidies for renewable energy sources have decreased compared with the levels reached before the COVID-19 crisis[5].

Carbon lock-ins — where past investments in carbon-intensive infrastructure and technologies linked to fossil fuels make it difficult and costly to transition to low-carbon alternatives — have long-term, detrimental impacts on the progress of electrification and need to be avoided[17]. As domestic production of oil and gas continues to dwindle, Member States face a widening gap between demand and supply. As previously mentioned, 98% of all oil and all gas used in Member States in 2022 was imported, posing risks of supply shortages and price volatility[5].

Up to 2030, there still needs to be compound annual growth of more than 8% to meet the new, binding EU target for renewable energy sources of 42.5%[14,18]. Meeting this target would reduce the fossil fuel-based generation of electricity in the EU. This would play a crucial role in reducing the large spillover effect of high gas prices on electricity prices, lowering the high costs of fossil fuel imports, improving the security of the EU's energy supply and boosting industrial competitiveness.

The strong growth in renewable energy generation over recent years has already pushed down average EU spot prices for electricity from their peak in 2021[19]. By 2030, assuming the EU's benchmarks are met, average annual spot electricity prices will have fallen across all EU countries, compared with 2023[5].

In spite of this, retail electricity prices for households — which also include national taxes and levies — were higher in 2023 and 2024 than before the energy crisis and also higher than prices for all other fossil fuels[19]. Under these circumstances, there is a risk that consumers deprioritise electrification. If this were to happen, then carbon lock-ins would be reinforced and the transition would slow down. Thus, it is very important to close the gap between electricity and fossil commodity prices across the whole energy system. The proposal for a revised energy taxation regulation and the adopted EU ETS2 have important roles to play in this regard[5]. The recent Clean Industrial Deal also aims to reduce energy prices by creating joint purchasing ventures and by completing the Energy Union.

Additionally, reaching EU targets for electrification and the deployment of renewables requires three key developments:

- improving the availability of capital and the overall investment leverage to compensate investors for the additional upfront costs of renewable infrastructure;
- enhancing power grids, demand response and storage to double the flexibility of resources across the EU's electricity system; and
- enhancing cross-border planning and integration of key infrastructure, flexibility solutions and markets to reduce inefficiencies resulting from uncoordinated national initiatives[5].

As with most technology transitions, the transformation of the energy system has been generating trade-offs. While recent studies show that the availability of land is not a physical constraint for the deployment of renewables across Europe[20], Member States and local authorities need the skills, resources and tools to manage the development of a distributed energy system, with the 2030 target setting an increasingly pressing deadline. The demand for raw materials and the environmental impacts associated with their extraction also need to be managed proactively.

Nuclear power is an option in the toolbox for decarbonisation, although Member States remain divided between those that embrace the technology's benefits[21,22] and those that remain wary of its prospects for sustainability, further incidents and the high cost of new plants compared to renewables.

Today there are more than 100 nuclear power reactors in 12 Member States, producing more than 22% of the EU's electricity. It is expected that nuclear power will remain a significant source of electricity generation in the EU over the next 20 years[23]. In a recent report, *Towards EU climate neutrality: progress, policy gaps and opportunities*, the European Scientific Advisory Board on Climate Change (ESABCC) concluded that delaying the closure of existing nuclear reactors can ensure access to a low-carbon energy supply in the short term when cost-effectiveness and safety can be guaranteed[24].

However, the construction of new nuclear plants is currently not a profitable investment in Europe. The long lead time for constructing new nuclear power plants (10 to 15 years) implies that an expansion of nuclear capacity will not alleviate the supply challenges in the short to medium term. The EU is dependent on uranium imports to fuel its nuclear power plants, with one-fifth of the EU's uranium supply coming from Russia in 2020. The ESABCC suggests that the potential contribution of nuclear power to the 2050 climate neutrality target should be weighed against these risk factors[24].

The energy system is also an important user of biomass[25], mostly in the form of solid wood to heat buildings. The use of biomass for energy generates emissions of particulate matter and volatile organic compounds[26]. Hence, it impacts air quality and competes with other land uses to produce biomass.

As mentioned above, the EU has made good progress in reducing the overall FEC between 2005 and 2023 by 12% and achieving a 19% reduction in the PEC[7,8]. However, the growing trends in the digitalisation of society and the economy point to some areas of increasing energy consumption. The uptake of technologies like artificial intelligence (AI), cloud services, digital currencies and the on-demand economy threatens the achievement of energy reduction targets, as these developments are associated with high energy demand[5,27,28].

The ongoing transformation of the energy system to a climate-neutral economy in the EU also requires adequate measures to identify vulnerable groups at risk of energy poverty and help them make energy-efficient and sustainable choices without being exposed to risks of poverty and resulting social exclusion[29]. In 2022, over 41 million Europeans were unable to keep their homes adequately warm.

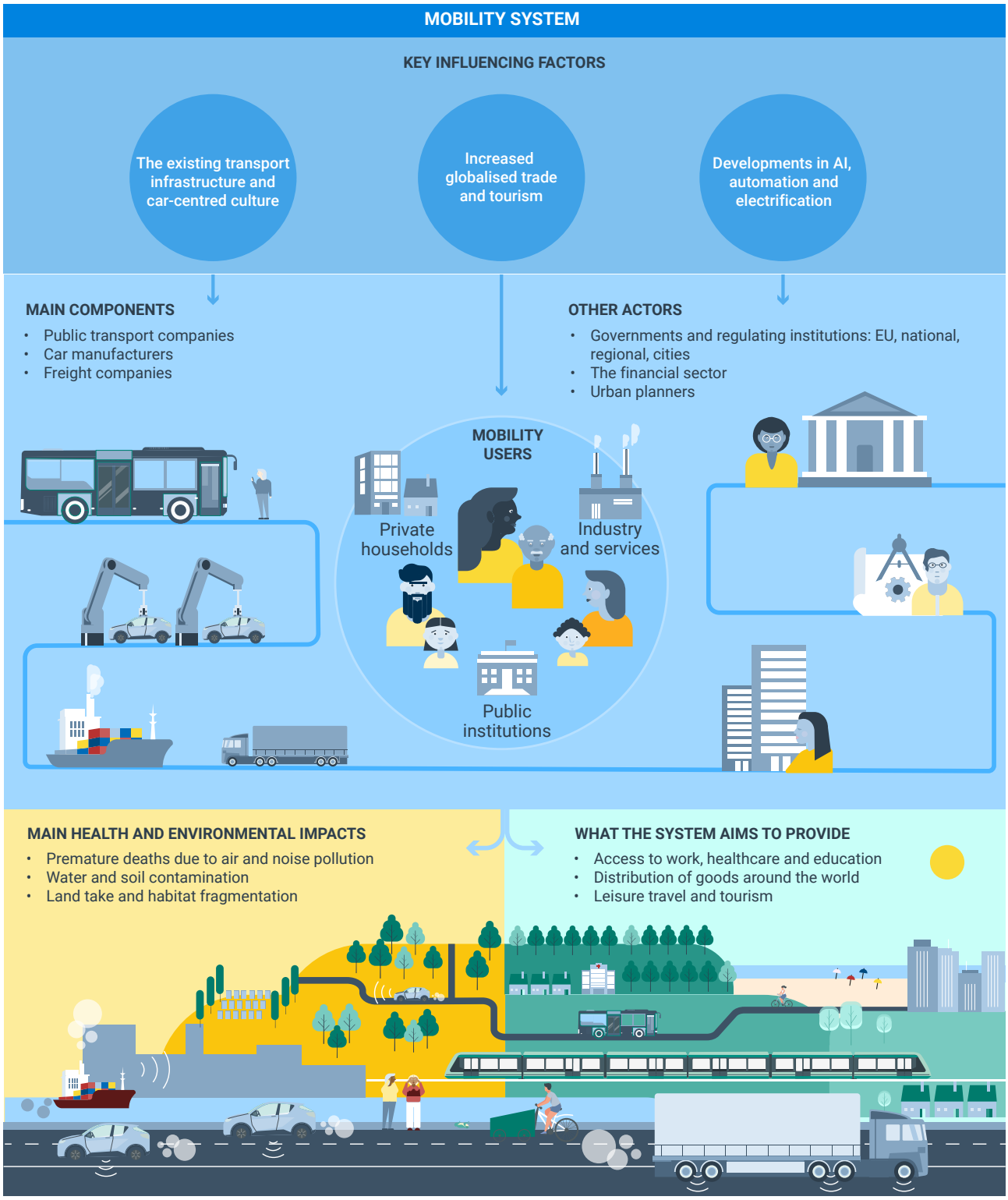
Energy poverty is a multi-dimensional phenomenon, considered to be caused by a combination of low income, high energy expenses and poor energy efficiency in buildings[29,30]. Recent lessons from national responses to the energy crisis show that national policymakers are struggling to direct funds effectively to the most vulnerable households. As such, it is critical that national emergency relief measures are better tailored to the needs of the population in the future[19,31].

Lastly, climate change is still posing ever-increasing risks to the energy system. Pressures on energy infrastructure are growing due to the heightened frequency of extreme weather events. For example, hydropower production or the cooling requirements of key power-producing infrastructure, such as nuclear power stations[32] could be affected by seasonal water scarcity. In 2022, drought in combination with heatwaves affected several regions in Europe and led to historically low hydropower outputs and reduced generation by nuclear reactors due to a lack of cooling water.

More information on Europe's energy system can be found here, in Sections 3.1.4, 3.2.4 and 3.3.4 on drivers and pressures, and in the briefing 'Trends in the energy system'. In addition, an assessment by the countries on their challenges and solutions towards a more sustainable energy system is provided in the country profiles of *Europe's environment 2025*.

5.2 Mobility system

Figure 5.4 The mobility system



Source: EEA, 2025.

5.2.1 Systems-level EU policies

The European Climate Law writes into law the goals set by the European Green Deal (EGD) in 2020: to reduce net GHG emissions by 55% by 2030 compared to 1990 levels and to reach net-zero by 2050 in the EU as a whole. The Sustainable and Smart Mobility Strategy provides a roadmap for achieving those emission reductions. The Fit for 55 package addresses all sectors to meet this target by creating the necessary conditions to comply with the obligations set by the Climate Law. Such key initiatives include the reFuelEU aviation and fuelEU maritime regulations, which aim to support the supply and demand of sustainable fuels in those sectors.

In addition, the Efficient and Green Mobility package has introduced proposals to modernise the trans-European transport network. This includes requirements for high-speed rail tracks and sustainable urban planning. Other proposed measures address ways to make freight transport and urban mobility in Europe more sustainable. The end-of-life vehicles regulation, currently under revision, aims to make vehicles more sustainable and circular across their lifecycles.

The 2023 revision of the ETS2 is set to become fully operational in 2027 and will expand the current ETS to address fuel combustion in road transport, buildings and other sectors not previously covered.

5.2.2 Progress and challenges

The transport system in Europe remains dominated by vehicular transport, with passenger cars responsible for more than 75% of transport activity in Europe (measured in passenger kilometres) and the number of vehicles increasing in recent years. While public transport offers a more sustainable profile compared to private modes of transport, its share of total passenger transport has changed very little[33].

Road freight transport activity continues to grow significantly, with 53.8% of all EU freight transport activities in 2022 carried by road[33]. Meanwhile, the relative importance of rail in total freight transport activity decreased compared to 1995 but is expected to expand in the coming decade. Due to its high energy efficiency and low GHG and air pollution emissions, the expansion of the rail sector provides a significant opportunity to reduce the environmental impacts of transport[33].

Modal shifts in the mobility system require concerted actions to overcome the lock-ins created by past investments and planning in urban areas. To challenge the continuing dominance of the private car[34], the EU must address the lock-in created by the vast European road network, urban structure and the significant investments channelled into road infrastructure over the past decades.

The wide availability of roads makes owning a car or moving goods by truck the most convenient options, while money spent on the road network is diverted away from more sustainable forms of transport[35,36]. Cities have, to varying degrees, been at the forefront in this area, developing networks of public transport and adapting them to evolving demand and mobility patterns — often despite limited budgets[37]. Brussels, for example, has launched Good Move Brussels, a model for sustainable and people-centred mobility (See Box 5.3).

Box 5.3

Good Move Brussels: a model for sustainable and people-centred urban mobility

The Brussels-Capital regional mobility plan, Good Move (2020-2030), is a transformative, citizen-focused strategy that prioritises quality of life, safety and sustainability. Moving beyond infrastructure-heavy approaches, it promotes multimodal transport, reduces car dominance, and encourages active travel and efficient public transport.

A standout feature is the creation of 50 good neighbourhoods where traffic is managed to reduce through-traffic and prioritise pedestrians and cyclists. A city-wide 30km/h speed limit enhances safety and supports active mobility. The 'STOP' hierarchy — giving priority to pedestrians, cyclers, public transport and only then cars — guides road planning and design across the region.

Mobility as a Service plays a central role, offering a unified digital platform for accessing shared bikes, public transport, taxis and other services. Intermodal hubs and park-and-ride facilities at city edges support seamless transitions between modes. These are reinforced by coordinated pricing, car taxation reform, and strong support for electric and shared mobility.

Importantly, Good Move is also notable for its participatory governance. Developed over four years with input from residents, municipalities, operators and civil society, the plan ensures alignment across all levels of government. Municipalities are using local contracts to implement neighbourhood-specific actions, such as school streets and delivery hubs.

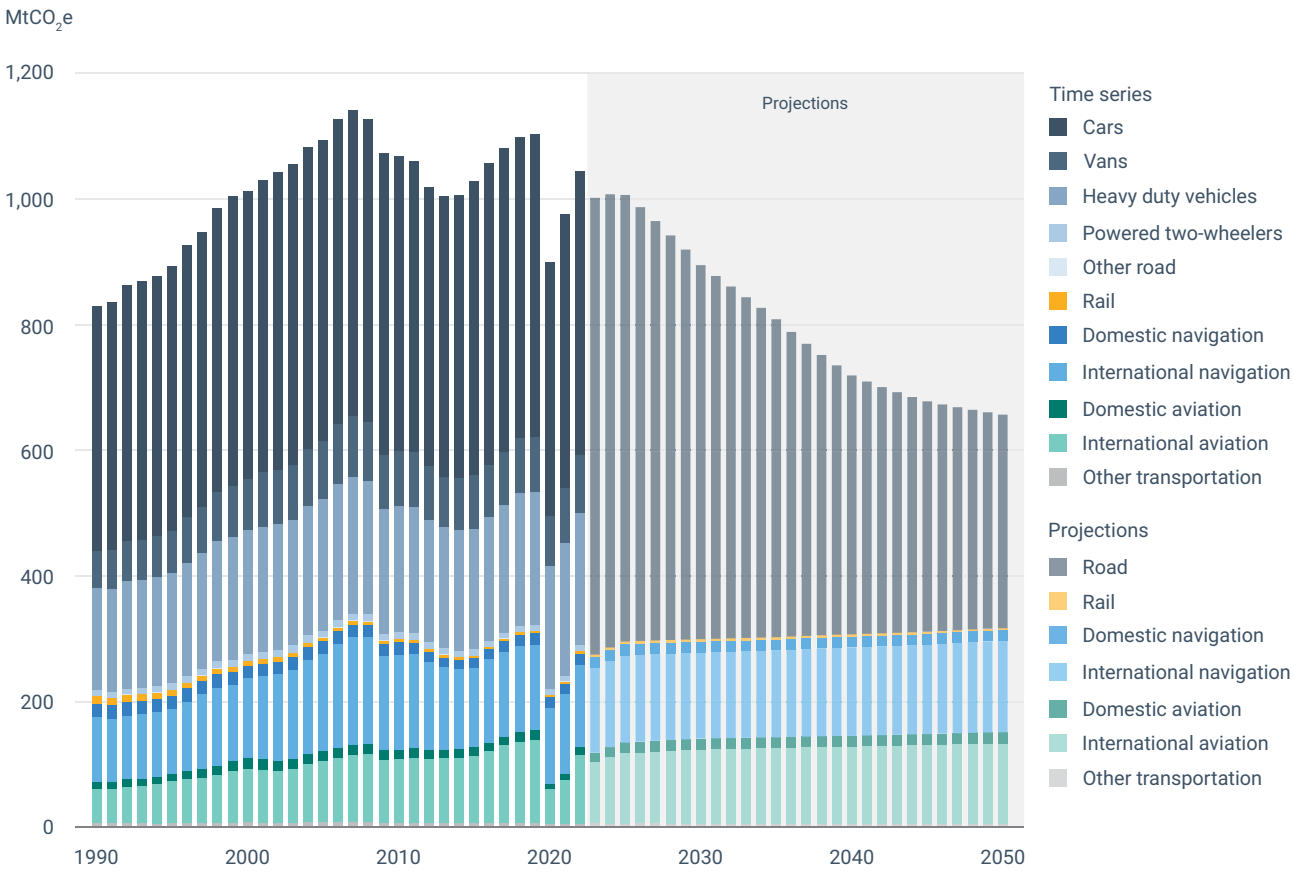
Early results are encouraging: cycling has doubled since 2020, traffic injuries have declined, and retail areas in calmed zones are seeing increased footfall. Reduced traffic volumes have led to lower noise levels and improved air quality, enhancing residents' well-being.

Good Move demonstrates how integrated planning, local engagement and service-oriented thinking can create safer, greener and more liveable cities — setting a benchmark for urban mobility transformation across Europe[38]. See also Belgium's country profile.

In 2022, the road sector was the largest consumer of energy, using 74.1% of all the energy used by the entire transport system. Most of this energy, 93.3%, was of fossil origin. Total FEC increased across all transport sectors between 1990 and 2019, with an increase per sector ranging from 30.1% to 129.4% with international aviation bunkers showing the most pronounced growth[33].

In 2023, GHG emissions from the transport sector — including both EU domestic transport and international transport activities — represented more than 30% of all EU GHG emissions. Most of these emissions were from road transport, while international navigation and aviation were the second and third most significant sources (see Figure 5.5). Based on projections from Member States, those two sectors are expected to account for a progressively larger share of Europe's GHG transport emissions in 2050[39].

Figure 5.5 Share of GHG emissions from different transport modes in 2022



Source: EEA[39].

Over the past few decades, the combination of policy measures and technological developments has led to a decrease in most emissions of air pollutants related to transport and mobility activities. This reduction ranges from 49% to 88% — depending on the type of air pollutant[33]. As a result of increasingly tight emissions standards, significant reductions in exhaust emissions from the road transport sector have been made possible and account for the greatest share of this progress.

Nevertheless, significant challenges remain, most of them linked to the continuing demand for transport. Efficiency gains, the use of biofuels and, to a lesser extent, the recent uptake of electric vehicles have led to a modest decline in GHG emissions from transport since their peak in 2007. However, all in all, GHG emissions from transport are still substantially higher now than in 1990. This illustrates that over recent decades, the gains derived from improvements in energy efficiency and technological developments have been offset by the increase in transport demand, resulting from the fact that individual cars remain the main mode of transport. This trend means that managing demand whenever possible is a necessary ingredient in mitigating the impacts of mobility[33].

Looking at noise pollution from transport, 30% of the population (in the EU plus Iceland, Norway and Switzerland) is exposed to long-term noise levels from road, rail and aviation at a level that harms health according to the World Health Organisation (WHO)[40]. Road traffic is the main source of noise pollution in both urban and non-urban settings. The number of people exposed to these harmful levels of long-term transport noise has broadly remained stable since 2012[41]. Faced with this problematic situation, the city of Zurich has been fighting against harmful noise levels by acting on speed limits (See Box 5.4).

Box 5.4

Speed limits as a noise intervention: insights from Zürich, Switzerland

In Zurich, about 125,000 residents live on streets where road noise exceeds exposure limits, harming health and quality of life. To address this, and in line with Switzerland's Environmental Protection Law and Noise Abatement Ordinance, the city began reducing speed limits from 50km/h to 30km/h in selected areas.

Rolled out in phases since 2012, the programme initially covered 40km of road. In 2021, the city accelerated the plan by approving an additional 150km of 30km/h zones, with completion expected by 2030 pending legal and administrative reviews. Once fully implemented, 48,000 residents are expected to benefit from lower daytime noise and 95,000 from less nighttime noise.

Measurements in Zurich and similar cities show that reducing speed to 30km/h cuts average noise by 3-4dB. Health impact surveys reveal less sleep disturbance and annoyance beyond what noise reductions alone would predict, suggesting benefits from smoother driving and fewer peak noise events. Residents with bedrooms facing streets experienced the greatest improvements; those facing inner courtyards noticed minimal change. These insights were gathered through a longitudinal survey by the city of Zurich and Switzerland's Federal Office for the Environment (BAFU) between 2017 and 2020.

The initiative, aside from some public transport adaptation costs, is low-cost, effective, and aligned with broader goals such as promoting cycling and enhancing public spaces. Public surveys show strong support for 30km/h zones, reinforcing their value as a simple, synergistic strategy to improve urban living conditions.

See Switzerland's country profile for details of national action in the mobility sector.

Looking forward, EU performance standards require that 100% of new cars and vans have zero CO_2 emissions at the tailpipe from 2035. This is an important step to transition away from internal combustion engine vehicles. Decarbonisation targets have also been implemented for heavy-duty vehicles, albeit at a different pace. In order for these ambitious targets set by the EU's mobility and transport strategies to deliver their foreseen effects, it is now crucial that policy can be implemented, and the required infrastructure can be developed, at the national level and at the necessary speed.

To reach these goals, a significant increase in the uptake of zero-emission vehicles will be needed. Electric cars — battery electric vehicles (BEVs) and plug-in hybrid electric vehicles — are penetrating the EU market. A steady increase in the number of new electric vehicle registrations in Europe was observed up to 2019, with growth from 600 new electric vehicles registered in 2010 to 400,000 in 2019 — equivalent to almost 3% of total car registrations. This was followed by a rapid acceleration in registrations of electric cars between 2020 and 2023. In 2024, however, the uptake of electric cars in the EU slightly declined. Electric vehicles accounted for 21% of newly registered passenger cars, with BEVs accounting for 14%, while plug-in hybrid electric vehicles represented 7% of total new car registrations[42].

BEVs have lower GHG emissions overall across their entire lifecycle compared to equivalent internal combustion engine vehicles. However, the actual difference depends on several factors. The environmental impacts of BEVs vary significantly based on the country where the different life-cycle phases occur. For BEVs, as for internal combustion engine vehicles, the use phase is the most impactful, which means that the power source providing electricity during that phase is most significant for the overall environmental impact profile of each BEV[43,44]. As the

proportion of renewable electricity increases and coal combustion decreases in the European electricity mix, the advantage of BEVs over internal combustion engine vehicles — in terms of GHG emissions and air quality — is likely to increase[40]. It is therefore important to promote BEVs and renewable energy sources concurrently, as well as the development of BEV supply chains in countries with high renewable energy penetration.

Another caveat with BEVs remains the use of raw materials, some of which are not available in the EU and are in high demand. This situation creates potential bottlenecks in supply as is the case for rare earth materials, which are essential for the construction of permanent magnets that compose both electric traction motors for electric vehicles and wind turbine generators[45].

In terms of impacts on human health, it is important to take into account that BEVs still emit particulate matter locally from road, tyre and brake wear, as do all motor vehicles. They are also responsible for emissions from their production and end-of-life phases and, as for the use phase, emission and impact levels depend on the energy mix where those phases take place. Additionally, while the noise pollution from BEVs can be lower in urban areas, it is equivalent in rural areas and on motorways[46], and the artificial engine noise that must be added for safety reasons is limiting the potential decrease in urban areas[40]. Overall, as BEVs are deployed in increasing numbers, it will be important to monitor the cumulative impacts over their lifecycles[44].

Demand for and the impacts of mobility decreased during the COVID-19 crisis but quickly bounced back once lockdowns were lifted. This is not surprising since transport is intrinsically linked to the economy: primary resources need to be moved to factories, produced goods need to be moved to be sold and people need to go to work, for example. These strong interlinkages make it challenging to fundamentally change the transport system.

To speed up reductions in the environmental impacts from the transport sector and curb the increasing demand for transport, national policymakers must look at broader enablers. It is necessary to develop comprehensive national strategies to manage mobility, including instruments to promote public transport, more active means of transport such as walking or cycling, and circular mobility business models such as car-sharing.

Despite seeing some progress, maritime transport continues to exert significant environmental pressures; it was responsible for 11.6% of the EU's GHG emissions from transport in 2023[6]. Other key pressures include emissions (albeit with a notable decrease in total sulphur oxides (SO_x) emissions), discharges of oil from ships, the spread of non-indigenous species, marine litter, impacts on the seabed in nearshore areas, and effects on wildlife from noise and collisions[47].

The fuelEU maritime regulation, implemented in January 2025, mandates a progressive reduction in the GHG intensity of the energy used on ships (from a 2% decrease by 2025 towards an 80% reduction by 2050); this aims to incentivise the uptake of low- and zero-carbon fuels as well as create demand for onshore power supply (OPS)[47]. OPS describe onboard and onshore infrastructure that allows ships to shut down their engines while berthed and plug into an onshore power source[48].

In 2023, aviation was responsible for 2.5% of global energy-related CO_2 emissions, experiencing a faster growth rate in recent decades compared to rail, road or shipping[49]. At the EU level, aviation is the sector which has experienced the largest

relative increase in GHG emissions since 1990, mostly driven by international aviation. The sector was responsible for 12.9% of all GHG emissions from transport in the EU in 2023[6].

The reFuelEU aviation regulation requires airport fuel suppliers to ensure that 2% of all aviation fuel is in the form of sustainable aviation fuels (SAF), with this share rising to 6% by 2030 towards a 70% share by 2050. However, the transition to SAF will require a sustained investment in research and development (R&D) as well as ways to support greater compliance, which remains difficult due to higher costs and the aviation sector's typically long development cycles and high technological barriers[5].

In addition to CO_2, pollution from aviation also extends to nitrogen oxides (NO_x) and other pollutants, leading to the formation of contrails — high-altitude clouds that reflect incoming solar radiation and trap outgoing heat[50]. Those effects account for two-thirds of aviation's total climate impacts and, as such, can contribute significantly to climate change[51]. Since January 2025, new EU monitoring and reporting rules now include non-CO_2 effects, with a first objective of better understanding these effects and their impacts[52].

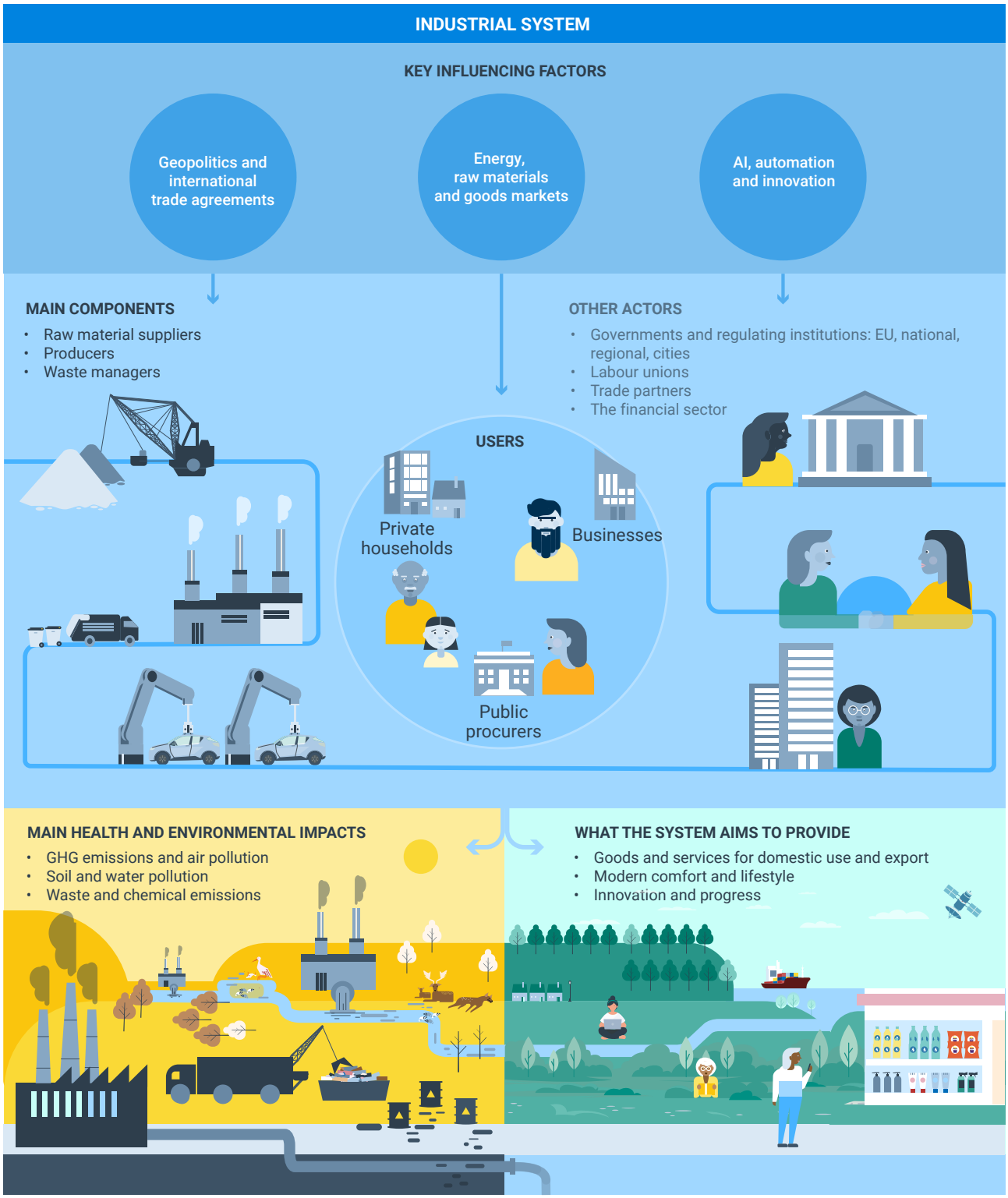
Continued public and private investments in innovation and technology, along with the implementation of existing EU legislation, are required to speed up the sustainable transition of Europe's mobility system. For example, the revised ETS directive commits Member States to spending all ETS revenues on climate action, energy transformation and addressing social challenges (up from 50% previously). Following the 2023 revisions of the ETS directive, ETS2 will address the CO_2 emissions from fuel combustion in road transport.

The revised ETS2 directive also directs more funding to the Innovation and Modernisation Funds. In this context, the Innovation Fund deploys around EUR 40 billion for research and demonstration of innovative low-carbon technologies. Such technologies include the production of low- and zero-carbon fuels to decarbonise the maritime, aviation, rail and road transport sectors, including collective forms of transport such as public transport and coach services. For aviation, it may also support electrification and actions to reduce the overall climate impacts of aviation.

More information on Europe's mobility system can be found here, in Sections 3.1.4, 3.2.4 and 3.3.4 on drivers and pressures, and in the briefing 'Trends in the mobility system'. In addition, an assessment by the countries on their challenges and solutions towards a more sustainable mobility system is provided in the country profiles of *Europe's environment 2025*.

5.3 Industrial system

Figure 5.6 The industrial system



Source: EEA, 2025.

5.3.1 Systems-level EU policies

Key legislation governing environmental pressures from the industrial system include the IED 2.0 (revised in 2024), the industrial emissions portal regulation, the national emission reduction commitments (NEC) directive and the REACH regulation on chemicals (to be revised in the chemicals industry package announced by the European Commission in April 2025). The ETS, as amended under the Fit for 55 package, will play a crucial role in the decarbonisation of the industrial system.

The Net-Zero Industry Act aims to scale up the manufacturing of clean technologies in the EU, while the Critical Raw Materials Act aims to make the EU less dependent on imports of critical raw materials by fostering domestic supply of both primary and secondary materials.

Most recently, the Clean Industrial Deal has set out objectives for EU competitiveness and decarbonisation, with a focus on energy-intensive industries and clean tech. Key objectives of the deal are set out in Box 5.5.

Box 5.5

The Clean Industrial Deal (CID)

The CID, launched in early 2025, aims to boost the industrial base of the EU by combining decarbonisation with competitiveness opportunities under the same policy agenda. For this reason, the main focus of the deal is on energy-intensive industries and clean tech. It comprises six business drivers.

First, recognising that affordable energy is one of the pillars of EU industrial competitiveness, the Affordable Energy Action Plan has been adopted to lower energy bills, accelerate the roll-out of renewable energy and complete the Energy Union.

Regarding clean tech, the deal proposes measures to boost demand for decarbonised products, making use of public procurement non-price requirements – such as sustainability criteria – and voluntary labelling schemes, thus creating lead markets for such products. Financing the clean transition is another objective of the deal; it aims to provide approximately EUR 100 billion through the Industrial Decarbonisation Bank but also mobilise private investments.

Circularity is key to the success of the deal as a means to secure EU supply with critical materials, reduce dependencies and boost competitiveness through a single market for recyclables and secondary materials.

The deal aims to increase the EU's global market share for clean tech by extending trade agreements and attracting foreign investments in its clean industry, while the Carbon Border Adjustment Mechanism (CBAM) will be reviewed to reflect these new policy developments.

Lastly, the deal will support the potential of clean industry to foster high-skilled jobs, without neglecting workers in transition.

In the framework of the CID, sectoral plans are developed that will tailor measures to the specific needs of individual sectors, such as the Action Plan on Steel and Metals. This plan aims to increase the sector's competitiveness so that the EU's security is guaranteed now and in the future. To support the steel and metals sector, the plan also makes use of tools described in the CID, such as power purchase agreements, the review of the CBAM and circularity measures.

5.3.2 Progress and challenges

Industry was responsible for 22% of total GHG emissions in 2023[6]. In terms of progress, industrial GHG emissions fell by more than 35% from 2005 to 2023. While reductions in previous decades can be attributed to the restructuring of the European economy, significant decreases in process-related emissions and improved energy efficiency, substantial reductions from 2021 to 2023 were partly linked to a decrease in industrial output[53]. Energy-intensive industries were greatly impacted by the COVID-19 pandemic, as well as spikes in energy prices and the loss of access to natural gas caused by Russia's war against Ukraine; these factors led to a 10-15% drop in production levels between 2021 and 2024[54].

Continued decarbonisation of the industrial system will require large-scale electrification (enabling the use of renewable energy), switching to hydrogen for certain industrial processes and substituting fossil raw materials with renewable ones, for example in the chemicals industry. However, progress on industrial electrification has stagnated in the past decade[55]. The CID sets out a number of measures to support industry in this transformation, creating clear business incentives for industry to decarbonise within Europe (see Box 5.5).

Energy-intensive industries in the EU are subject to higher energy costs than global competitors, which harms their competitiveness[56]. The Action Plan for Affordable Energy aims to reduce energy costs in the EU by accelerating electrification and the transition to clean domestically generated energy, completing the internal energy market with physical interconnections and grids and ensuring well-functioning gas markets.

Historic reductions in the main air pollutants from industry have been an important co-benefit of decarbonisation measures like shifting towards more renewables and a phase-out of coal. As the climate and energy transition continues, further co-benefits can be expected in terms of reductions in air pollutants.

At the same time, there is a need for new and additional measures. For example, circularity measures offer broad and important co-benefits and promising synergies between environmental objectives such as decarbonisation, zero pollution and resource efficiency, compared to end-of-pipe GHG control measures.

Beyond the focus on reducing direct GHG emissions from industry, there are also opportunities to lower environmental impacts across the value chain. For instance, in the steel industry, there are low-carbon technologies that do not rely on coking coal. These not only have reduced CO_2 emissions but also contribute to a reduction in methane emissions associated with coal extraction.

Methane is a potent GHG but also a precursor of ground-level ozone[57]. Ozone is a cause of respiratory diseases and leads to an estimated 70,000 premature deaths in the EU annually[58]. The EU's decarbonisation plans can thus deliver important co-benefits in reducing emissions. These include preventive health benefits which have been proven to offset societal costs associated with pollution control.

A key challenge is to continue to develop comprehensive decarbonisation measures for industry while also taking into account their environmental impacts across the value chain and addressing possible trade-offs related to areas such as water consumption and ecosystem degradation. For instance, hydrogen production is highly water-intensive, and the use of biomass as feedstock by the chemicals industry could widen the gap between biomass supply and demand in Europe[59].

Equally, plans to fast-track mining operations and processing plants of critical raw materials that are needed for decarbonisation technologies may reinforce ecosystem trade-offs and exacerbate broader socio-political risks[60]. On the other hand, strategies for reducing demand for such materials have been underexplored to date and offer important opportunities[61].

Industrial emissions of key air pollutants declined slightly from 2012 to 2021[62] and overall there has been greater progress in reducing emissions to air (See Box 5.6) than emissions to water. Thus, more effort is needed in these areas as the health and environmental costs remain high[62].

Not all pollutants are adequately monitored and new knowledge is drawing attention to harmful pollutants such as per- and polyfluoroalkyl substances (PFAS). Additionally, while some of the pressures from industrial production within the EU have decreased, the consumption of goods continues to increase. The pollution burden linked to the industrial activity needed to meet increases in EU demand for goods has been increasingly delegated to third countries to which polluting industrial activities have been outsourced[63,64] (see thematic briefing 'Circular design and sustainable production').

Box 5.6

Progress in reducing the external costs of air pollution in Europe

Industry in Europe has made significant progress in reducing its environment and climate impacts. Over the last decade, the external costs of air pollution from industry decreased by nearly 35%, although they rebounded somewhat after a drop in 2020 driven by lower economic activity in Europe during the COVID-19 pandemic. Almost 80% of the decrease in total external costs during the last decade occurred in the energy sector (thermal plants generating electricity and heat). This has been driven by the successful implementation of best available techniques in the sector and a shift to less polluting and less carbon-intensive fuels driven by environmental and climate policies[62].

For example, between 2004 and 2022, SO_2 emissions from large combustion plants fell significantly in the EU. This reduction was driven by stricter regulations and shifts toward cleaner fuels. All Member States successfully reduced their SO_2 emissions between 2004 and 2022 through improved abatement technologies and the replacement of coal by natural gas and renewable energy sources, with the single market levelling the playing field. This proves the effectiveness of EU policies in this area — namely the large combustion plant directive, replaced in 2010 by the industrial emissions directive. In 2004 the relative performance of countries varied significantly but today all countries perform at very similar levels, including Member States that joined the EU in 2004, 2007 and 2013[23].

There is an increasing focus by industry on the extraction and supply of metal ores and minerals essential for various manufacturing processes. This includes materials needed for technologies that are part of the decarbonisation process in energy-intensive industries, such as industrial heat pumps and hydrogen direct reduced iron — a process of steelmaking where carbon-rich input materials are replaced with hydrogen[65].

Meanwhile, the demand for emission-intensive materials in the EU has remained relatively stable and highlights the lock-in associated with fossil fuels and how it is entrenched in multiple industrial sectors such as chemicals, plastic, steel, cement, mining and textiles (See Box 5.7). The chemical production sector, which manufactures a broad range of chemicals, is tightly integrated with the fossil

fuel sector; petrochemicals are used as both feedstock and an energy source for production. The EU's reliance on chemicals and downstream products, such as plastics and fertilisers, increases its dependence on fossil fuels[24], thus reinforcing the lock-in.

In Europe, the average annual plastic consumption by end-users is around 105 kilograms (kg) per person— much higher than the global average[66]. Besides polluting the environment, plastic production contributes to climate change: annual emissions related to the EU's plastic value chain amounted to 193 million tonnes CO_2 equivalent in 2022 (more than the annual emissions of Belgium), with 85% of emissions being released during the production of plastics and conversion into products[66].

A negative trade balance has developed for steel in the EU[67]. This suggests that production outside the EU is meeting an increasing share of the EU's demand for steel than production inside the EU — with a likely negative impact on the EU's global environmental footprint. This development made the industry more vulnerable to supply chain disruptions and global market developments, but it has had the benefit of strengthening the focus on Europe's strategic autonomy. Supply-chain disruptions in the EU due to a period of geopolitical instability, especially in light of import dependencies, have placed a renewed focus on domestic production of critical technologies and raw materials. However, this focus potentially puts the EU's natural resources and ecosystems at risk in the future[67].

More information on Europe's industrial system can be found here and in Sections 3.1.4, 3.2.4 and 3.3.4 on drivers and pressures.

Box 5.7

Focus on the textiles system

The textiles system is highly globalised, with Europe being a significant importer and exporter. In 2023, the EU textiles and clothing sector had a turnover of EUR 170 billion and employed about 1.3 million people across 197,000 companies[68]. Almost 13 million full-time equivalent workers were employed worldwide in the supply chain to produce the amount of clothing, textiles and footwear consumed in the EU-27 in 2022[69].

At a time when online shopping, social media and influencers have been growing and fast-fashion business strategies predominate, EU consumption of clothing, shoes and household textiles has reached an all-time high of an average of 19kg consumed per person per year in 2022 — comparable to what can fit in a large suitcase. Of the 19kg, 8kg was clothing, 4kg shoes and 7kg household textiles[70].

Meanwhile, among all types of goods, textile consumption in Europe in 2022 caused the fifth-highest value chain pressures on land use and the use of primary raw materials, the fourth-highest water use, and the sixth-highest emissions of GHGs. About two-thirds of the total climate change impacts from textiles occur in the production phase. The textiles value chain also contributes to other environmental pressures not analysed in detail here. These include air pollution, chemical use and pollution, microplastics pollution from the production, use and washing of textiles, as well as pressures from processing textiles as waste once discarded[70].

Digital technologies can potentially reduce the environment and climate pressures from textiles by improving efficiency in the sector. However, they also risk contributing to increased production and consumption, for example through social media or online platforms[70].

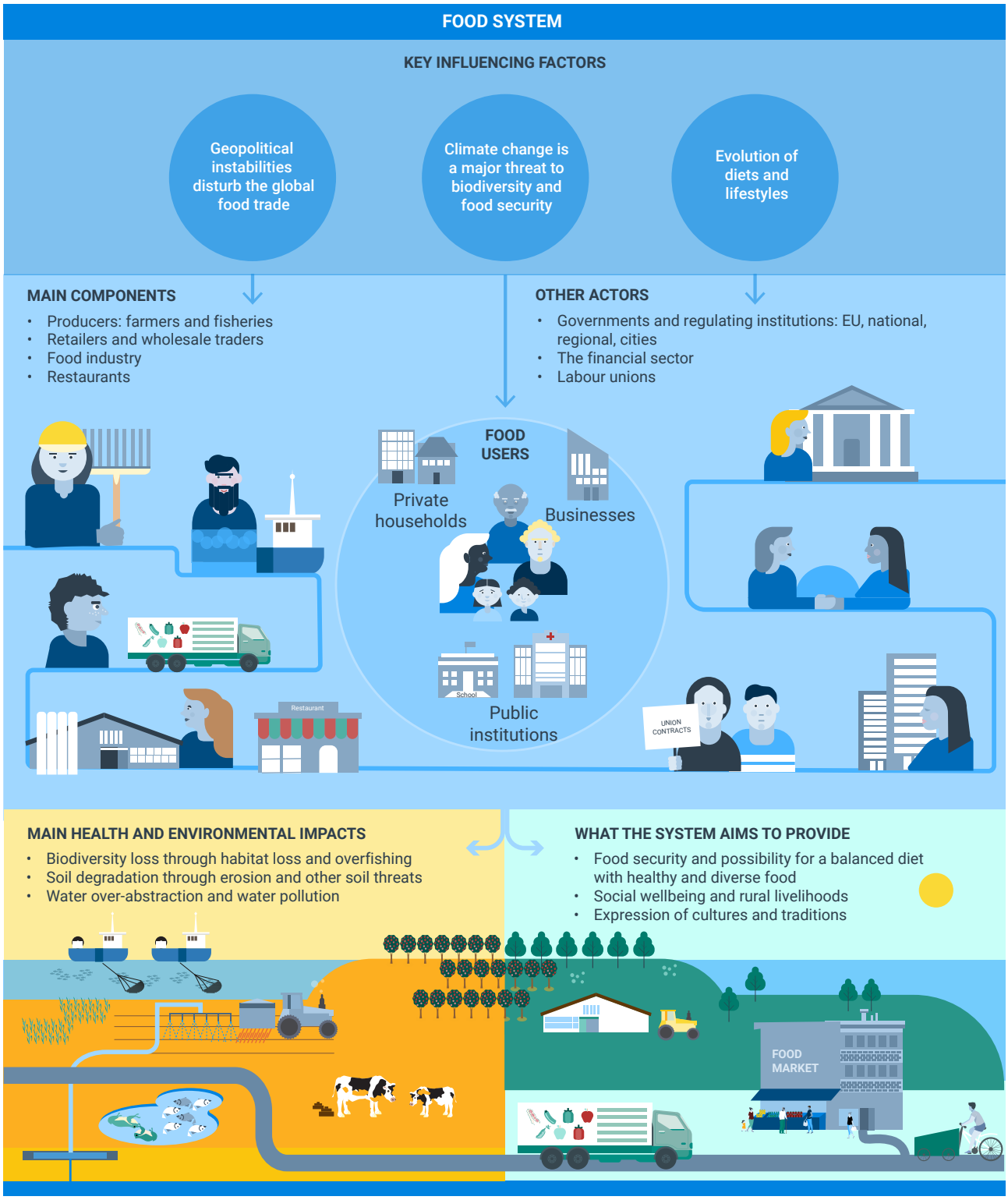
In 2022, EU Member States generated about 6.94 million tonnes of textile waste, which amounts to 16kg per person. The total amount of textile waste generation has remained relatively stable since 2016. The average capture rate for textile waste in the EU — an indicator of the effectiveness of separate collection systems — has been slowly increasing. In 2022, the capture rate was just under 15%. This means that 85% of all textile waste from households was not collected separately and instead ended up as mixed household waste, from which it can't be reused or recycled. Furthermore, an estimated 4-9% of all textile products put on the market in Europe are destroyed before use[71].

The export of used textiles has nearly tripled since 2000, reaching 1.37 million tonnes in 2023[72]. The main recipients of used textiles from Europe are Africa and Asia. Imported used textiles in Africa primarily go towards local reuse. What is not fit for reuse mostly ends up in open landfills and informal waste streams. Most used textiles in Asia are sorted, processed and mostly downcycled or re-exported for recycling in other Asian countries or for reuse in Africa. Textiles that cannot be recycled or re-exported are likely to end up in landfills[72].

The circularity and sustainability of textiles in the EU are affected by concrete policies associated with the implementation of the EU Strategy for Sustainable and Circular Textiles. These include the ecodesign for sustainable products regulation (ESPR), which introduces the mandatory development of digital product passports that provide information on a product to all actors along its entire value chain (from a simplified version in 2027 to a full circular version in 2033). It also includes, most recently, the targeted revision of the waste framework directive, which sets out new rules on waste textiles. A systemic shift in the textiles system is needed for the EU's textiles strategy to succeed in moving towards higher quality, longer use, reuse, repair and recycling.

5.4 Food system

Figure 5.7 The food system



Source: EEA, 2025.

5.4.1 Systems-level EU policies

The Common Agricultural Policy (CAP), Common Fisheries Policy (CFP) and strategic guidelines for EU aquaculture set out guidelines for agriculture, the fishing and aquaculture sectors. They also aim to contribute to the objectives of the Farm to Fork Strategy (F2F). The EGD introduced new initiatives such as the Action Plan for Organic Production in the EU to increase the demand for and supply of organic products.

Meanwhile, the EU Code of Conduct on Responsible Food Business and Marketing Practices is one of the deliverables of the F2F and sets out the actions that the actors 'between the farm and the fork' — such as food processors, food service operators and retailers — can take voluntarily to improve their sustainable performance. The European Food Security Crisis preparedness and response Mechanism (EFSCM) was also established under the F2F, as part of the contingency plan for ensuring food supply and food security in times of crisis.

Also impacting the food system are other environment- and climate-oriented strategies and policies, including, amongst others:

- Circular economy action plan (waste prevention, nutrient recycling, product labelling);
- Waste framework directive (waste prevention);
- Zero-pollution action plan (reduction of pesticides);
- European Climate Law and Fit for 55 policy package (decarbonisation of agriculture);
- Biodiversity Strategy for 2030 (biodiversity protection);
- Nature restoration regulation (NRR) (nature protection and restoration);
- Regulation on deforestation-free products (forest protection worldwide); and
- Soil Monitoring Law (soil protection and restoration).

Published in February 2025, the Vision for Agriculture and Food aims to build an attractive, competitive, future-proof and fair agri-food system for 2040[73] (See Box 5.10). It was followed in May 2025 by a first package of measures that began to address the simplification objectives announced in the vision[74].

5.4.2 Progress and challenges

Food systems are embedded in nature as food is provisioned by terrestrial, freshwater and marine ecosystems[75]. Agri-food systems rely on essential natural processes such as pollination[76] and soil formation[77], while fisheries depend on healthy aquatic ecosystems[78]. Biodiversity supports the resilience of agriculture and food security, in response to the changing climate. Current EU food self-sufficiency rates are generally high[79], although some dependencies exist, for example, the imports of animal feed[80].

However, due to nature degradation in Europe, ecosystems' capacity to support farming has decreased[81]. The health of agricultural soils is deteriorating due to the overuse of chemical inputs, monocropping, the insufficient replenishment of organic matter and unsustainable soil management practices[82]. Biodiversity loss weakens the resilience of ecosystems and may potentially have catastrophic effects on food production[83,84].

Food systems are a primary driver of ecological overshoot, and Europe's natural resource use is currently 1.5 times higher than its biocapacity. Food consumption alone accounts for nearly a third of Europe's total natural resource use, highlighting the urgent need for systemic change[85].

Environmental footprint assessments of food systems consistently point to negative biodiversity and climate impacts linked to primary production of food — especially in the production of animal-based products, particularly meat[85]. Animal-based products are the food category with the highest impact, driving significant land use, GHG emissions and biodiversity loss.

At the same time, extensive grass-based livestock systems are needed to maintain semi-natural habitats, while mixed livestock-crop farming can close nutrient cycles (a closed nutrient cycle describes a setting where the recycling of nutrients from soil to plants and back to soil is high and outputs are low), and their ongoing decline contributes to biodiversity loss[77].

Sustainable farming — in the form of agroecological and organic systems, for example — is a key approach for achieving sustainability[77]. The area used for organic farming in the EU has been increasing[86] from 5.9% to 10.5% between 2012 and 2022[87,88], though there are significant variations across countries (see the country profiles of *Europe's environment 2025*).

A positive example of action for biodiversity is Bavaria's citizen-led initiative to protect pollinators through organic farming, which is described in Box 5.8. Other positive examples include innovative agricultural policy schemes supporting biodiversity in the national CAP strategies, presented in Box 5.9.

Box 5.8

'Save the Bees!' referendum: strengthening nature conservation in Bavaria, Germany

In February 2019, Bavaria held a public referendum on the 'Save the Bees!' initiative, a landmark in regional conservation. Sparked by the alarming 'Krefeld study' — which found a 75% decline in flying insect biomass over recent decades in North Rhine-Westphalia nature reserves — the movement reflected growing concern over biodiversity loss, habitat destruction and food security.

Over 1.7 million Bavarians (18.3% of eligible voters) signed the petition, surpassing the referendum threshold. Support spanned rural and urban areas, signaling broad demand for stronger environmental protection.

The initiative sought to strengthen the Bavarian Nature Conservation Act through measures including a statewide network of interconnected habitats; preserving hedgerows, trees and small water bodies in farmland; green strips along streams and ditches; expanding organic farming; managing state owned land without pesticides; and embedding conservation in farmer and forester education.

Following the petition's success, a multi stakeholder roundtable united supporters and opponents to co develop a legislative package. On 17 July 2019, the Bavarian Parliament adopted 'Biodiversity and Natural Beauty in Bavaria', a binding set of measures.

Implementation has yielded notable progress, including the creation of orchards; the establishment of agri environment schemes; the expansion of flowering areas and grasslands; improved subsidies for sustainable grazing; and reduced herbicide use on state land. In November 2022, Bavaria achieved its target of protecting 10% of public forests as natural forests, adding three new reserves. The aim to establish a biotope network across 10% of open land is nearing completion.

This case shows how well informed civic action can catalyse significant policy change. It also highlights the role of production focused interventions — particularly in agriculture — in achieving lasting biodiversity gains.

See Germany's country profile for information on national action to increase the sustainability of the food system.

Box 5.9

Innovative agricultural policy measures supporting biodiversity in CAP Strategic Plans

Across the EU, CAP Strategic Plans include targeted interventions to support biodiversity alongside agricultural production. Several Member States have introduced innovative schemes that encourage voluntary environmental commitments, using results-based incentives and locally-adapted approaches that often deliver broader climate and ecosystem benefits. Four examples from Spain, France, Germany and Poland illustrate this diversity.

In Spain, the Autonomous Community of Navarra launched an agri-environmental measure that supports plant diversity in grasslands. Farmers commit to maintaining high or very high levels of species diversity over five years, with payments tied to outcomes. A mandatory advisory component provides training and tailored activity plans. In tandem, it links financial support to measurable ecological results, and empowers farmers with knowledge and planning tools.

In France, an agri-environmental sub-measure promotes species-rich, permanent grasslands. Farmers must maintain a minimum number of indicator species, ensure continuous soil cover, and avoid fertilisers and pesticides. Regional operators conduct agro-ecological assessments, involving local biodiversity experts and authorities to tailor actions to site-specific conditions, enhancing engagement and ecological relevance.

In Germany, CAP-funded measures incentivise peatland rewetting for biodiversity and climate benefits. Farmers rewet land for extensive grazing or paludiculture. The scheme can be combined with eco-scheme payments and cooperative interventions, enabling coordinated landscape-scale restoration, improved hydrology and habitat diversity.

In Poland, agri-environmental schemes promote extensive grassland management aligned with traditional land-use systems. Requirements vary by site, including grazing limits and mowing restrictions. Natura 2000 sites follow official plans, while other areas receive expert assessments and tailored management strategies to meet conservation goals.

These examples show how CAP implementation can deliver locally-grounded, biodiversity-oriented support. Innovative, flexible tools help align agriculture with nature restoration and long-term sustainability objectives[77].

Despite the progress made and ongoing positive initiatives, biodiversity decline has not been halted[89], water has continued to become more scarce[90] and there has been no significant reduction in GHG emissions[91].

The CAP 2023-2027 aims to increase green ambition with the introduction of new elements such as the requirements for Member States to allocate 25% of their direct payment budget to eco-schemes and 35% of their European Agricultural Fund for Rural Development budget to climate and environmental measures and animal welfare. The CAP 2023-2027 had also increased the EU's environmental ambition by strengthening rules for conditionality, meaning that stricter conditions needed to be met for the payment of funds. However, these rules were amended in 2024 and the focus of the CAP was redirected towards voluntary measures such as eco-schemes.

Eco-schemes cover a broad range of areas for action and support farming practices through various benefits. Member States can select which eco-schemes they offer to farmers and adjust their design. There is limited information about uptake levels by farmers to date, and it is therefore not yet possible to assess the overall environmental benefits of the eco-schemes. However, the regular revision of national plans allows for adjustments based on lessons learnt. This should make it possible to target policies towards the most beneficial farming practices, making a clear link between environmental benefits and payments.

The European Court of Auditors has called on the European Commission (EC) to promote exchanges of good practice for eco-schemes, key practices and approaches for tackling long-term climate and environmental challenges, and to estimate the CAP's contribution to the EGD's environmental and climate targets[89]. To meet the EU's environmental objectives, it will be crucial that the right balance is found between flexibility for farmers and Member States and the prioritisation of the most effective policy measures to support sustainable farming systems.

The Vision for Agriculture and Food, introduced in March 2025, followed the strategic dialogue on the future of EU agriculture and aims to establish a better dialogue and horizontal approach to shaping the EU's agriculture and helping establish this balance.

Box 5.10

Focus on the Vision for Agriculture and Food and the strategic dialogue on the future of EU agriculture

The Vision for Agriculture and Food, introduced in March 2025, launched a new way of working in policymaking, with a shift from a top-down approach towards a more participatory process. In line with the broader framing of the Competitiveness Compass, which identifies simplification as one of the 'five horizontal enablers for competitiveness', the vision includes the further simplification of CAP rules amongst its objectives, with more incentives and fewer requirements and conditions for payments.

The focus is on cost-effective implementation. The ambition is that faster and more attractive implementation of measures and funding will be more beneficial than stricter environmental regulations. The first package of measures, known as the CAP simplification package, was announced in May 2025, with more to be announced later in the year.

The vision and the CAP simplification package follow on from the strategic dialogue on the future of EU agriculture that took place in 2024 to address the polarised views on EU agriculture and create the space to bring stakeholders together. A push-back had been observed following the nature restoration regulation (NRR), mainly in relation to its potential economic impacts on agriculture.

It is an achievement that a broad EU-level dialogue has now started about the necessary transformation of the agri-food system, and an agreement has been reached across stakeholders in relation to the urgent need for change. Broad and open stakeholder dialogue can help shape future policies that respond to this need. At the same time, adjusting the implementation of national policy based on lessons learnt is also possible in this context and could be beneficial in the short term.

These changes have taken place at a time when the European agricultural sector has been facing challenges and changes amid rapid environmental, climatic and societal uncertainties[92]. Structurally, many small and medium-sized farms, or those in areas or sectors with other structural challenges or natural constraints, struggle to remain economically viable. Economic pressures, including fluctuating market prices, rising input costs and competition from global markets, exacerbate these challenges. Farmers' incomes are around 40% lower than those of other workers[93].

At the same time, factors driving the abandonment of farming and challenges to generational renewal — when younger individuals take over farms from retiring farmers — are complex and need tailored support from agricultural and other policies, such as social and employment policies[94]. Furthermore, the dominance of large corporations in the agri-food system has led to power imbalances that can also negatively impact smaller producers and limit consumer choices.

The vision aims to change this context by increasing how attractive and accessible the sector is to young farmers. Yet, for this kind of development to be truly impactful, there will need to be significant support to help those interested access land ownership and financial capacities. There will also need to be support for skills development and access to the new technologies now available for more sustainable and competitive farming.

The changes in overall geopolitical and economic contexts globally have further complicated efforts to reform the EU food system, with the debate over food sovereignty and strategic autonomy opening up in the wake of Russia's invasion of Ukraine. These developments have exposed the EU's dependence on imported agricultural inputs like energy, farm animal feed and fertilisers[95], raising concerns about supply risks[96].

Europe is both a major exporter and importer of food products. Intra-EU trade dominates, but the region also imports significant quantities of seafood, tropical fruits, coffee, tea, cocoa, soy and protein-rich fodder for EU livestock[97]. Europe outsources over 21% of its food-related environmental impacts to other regions through international trade[85]. Globalisation, while playing an important role in maintaining food security, has increased dependencies and trade volumes. This, in turn, has impacted the affordability of goods and exposed the EU to market volatility[98].

In the area of fisheries, the CFP aims to restore and maintain fish stocks above levels that can produce a maximum sustainable yield, namely the largest long-term average catch or yield that can be taken from a stock or stock complex under the prevailing ecological and environmental conditions[99]. Key provisions under the CFP and the revised monitoring and compliance rule — with environmental legislation and quota allocation based on transparent and objective criteria, including environmental and social ones — are designed to mitigate environmental harm. Fisheries would impact the environment much less if these core CFP provisions and rules were more consistently followed.

Despite success in some EU waters in reducing overfishing of some stocks, harmful practices and unsustainable fishing levels persist. There are implementation gaps, such as the inconsistent application of the landing obligation – rule stipulating that all catches of fish species regulated through catch limits or minimum size should be brought to land and counted against the fishers' quota as opposed to being discarded at sea – or the weak enforcement of marine protection. These gaps have hindered progress, perpetuating unsustainable practices and undermining marine resilience. These issues contribute to the EU's lack of success in meeting the CFP's objective of only exploiting all stocks up to a maximum sustainable yield.

In 2023, only 28% of assessed stocks were found to be sustainably fished and in good biological condition, with clear regional disparities. These conditions were met by 41% of stocks in the North-East Atlantic and Baltic Seas, compared to 9% in the Mediterranean and Black Seas[100]. The ongoing evaluation of the CFP represents an opportunity to strengthen compliance, improve data integration and align fisheries management with climate change adaptation. To reverse the degradation of Europe's marine ecosystems, it is essential for the current CFP to be fully implemented and rigorously enforced.

Total organic aquaculture production in the EU was estimated at 73,570 tonnes in 2020, accounting for 6.7% of all EU aquaculture production. This was 60% higher than in 2015 and Ireland was the main producing country[101]. Organic aquaculture in Europe has seen significant growth and recognition driven mostly by rising consumer demand for sustainable seafood options, though with large differences across Member States[102]. While the aims of the EGD and the F2F are clear, the Aquaculture Advisory Council — which provides advice to the EC and Member States on aquaculture production in the EU — considers that there are still a number of significant regulatory barriers inhibiting the growth of the organic aquaculture sector.

Seafood is one of the most globally traded food commodities, driven largely by globalisation and the geographical mismatch between production — e.g. aquaculture in Asia — and demand — primarily in Europe, North America and Asia[103]. Sustainability is becoming an increasingly important factor in the global seafood supply chain, yet efforts to improve it often remain focused on production. As consumption patterns play a critical role in shaping sustainability, consumer nations should take responsibility for what they consume — not just what they produce — and ensure that the entire seafood value chain is sustainable for each product[103]. Inefficiencies, such as poor traceability and redundant two-way trades — when countries both import and export the same types of goods — highlight the urgent need for improved management in the global seafood trade to meet sustainability goals and to empower consumers to make informed choices[104].

Consumption patterns have enormous implications for the environment. A more meat-based diet requires more resources (land, water, energy) than a plant-based diet, thus affecting more habitat area. The EU shows higher consumption levels in terms of calories (by 19%), protein (by 25%) and fat intake (by 75%) compared to the world average[105]. In particular, EU consumption levels for animal fats and milk are four and two-and-a-half times higher, respectively, compared to the global average, with the per capita supply quantity (in kg/capita/year) of both increasing by 13% between 2010 and 2022 in the EU[105].

As such, there is an urgent need for more sustainable dietary patterns in Europe. Changing consumption patterns, even a partial shift from animal-based proteins to sustainably grown plant-based proteins, would reduce water consumption in agriculture and dependency on imported feed[30,77]. Aiming to reduce the carbon footprint of the food sector, Denmark has taken action to promote a plant-based diet and strengthen the plant-based food sector (See Box 5.11).

Box 5.11

Rethinking food through social innovation: Denmark's Action Plan for Plant-based Foods

Denmark's Action Plan for Plant-based Foods, launched in October 2023, aims to shift both production and consumption toward plant-based alternatives through co-creation and voluntary action. Farmers, researchers, entrepreneurs, retailers and civil society are engaged through advisory boards and collaborative projects. They foster solutions rooted in experimentation, trust and shared ownership.

Up to 2030, a EUR 166 million fund is providing grants for innovation, skills and market development to accelerate growth in the plant-based food sector. Early rounds have supported more than 70 projects, including a zero-waste hub, legume-based proteins and fast-food concepts with plant-based menus.

The plan also includes adjustments to public food procurement, the integration of plant-based themes in education, and support for national networks and partnerships. Plant-based foods are presented as accessible, attractive choices that align with the green transition.

Crucially, the plan acknowledges that change impacts farmers and food workers, encouraging incremental adaptations aligned with existing practices rather than disruptive measures. This approach positions plant-based foods as an opportunity, and helps build legitimacy and broad public support.

See Denmark's country profile for information on national action to increase the sustainability of the food system.

Demand-side measures and initiatives are emerging at the country level, including school canteen programs, public procurement targets for organic products, the promotion of seasonal and local food, information campaigns about the environmental and health impacts of food as well as smart labelling, indicating a product's place of origin and total carbon footprint[106]. In parallel, although difficult to quantify, diverse bottom-up initiatives are proliferating across the food chain. These include community-supported agriculture, urban policy pacts and food policy councils, food waste solutions, innovation in plant-based food and food education[107].

These innovations are often enabled by new technologies and partnerships but vary in maturity[107]. For example, community-supported agriculture — a direct-to-consumer food production model where consumers pay farmers or cooperatives upfront — is relatively well established as a movement in many EU countries but remains niche in comparison to organic farming. Nevertheless, community-supported agriculture has experienced rapid growth in recent years, likely due to increasing environmental concerns and food supply chain issues experienced during the COVID-19 pandemic[108,109].

Meanwhile, awareness of the environmental impact of meat consumption[110,111] has led to a rise in the intake of plant-based proteins and milks, with an increase in the number of flexitarians, vegetarians and vegans, especially among younger consumers[112]. In the EU, the consumption of plant-based alternatives to meat and seafood products has grown fivefold since 2011. It is likely to continue to grow further, driven by a progressive shift in consumers' dietary choices[113], while the production and consumption of pulses are expected to increase, supported by policies favouring protein crops[113]. However, it should be noted that overall meat consumption is only slightly declining, with an increase in poultry consumption compensating for the decline in beef and pork[114].

Yet, while integration between food-based dietary guidelines and environmental aspects is starting to become apparent, including guidelines on low-meat, vegetarian or vegan diets[106,115], the average per capita intake of red meat, sugars, salt and fats continues to exceed health-based recommendations. In contrast, the consumption of whole grain cereals, fruit and vegetables, legumes and nuts is still insufficient[106].

The demand for organic food has been increasing in the EU, although it has become more unstable since 2022, and more efforts are needed to support the organic sector[86]. The number of organic agricultural producers grew from around 248,000 in 2012 to 426,000 (+72%) in 2022, while the number of organic aquaculture producers grew from 363 to 660 (+82%) in the same period[116]. Per capita retail sales of organic food products in the EU reached EUR 104.3 annually in 2021, but while the EU organic market more than doubled between 2010 and 2021, its growth rate in 2021 was less than 4%[117].

In the food processing, retail and services sectors, there has been increasing interest in sustainable solutions, due to consumer demand. Sustainability labels have proliferated on the market, though they need streamlining to be more effective[106].

Systemic approaches are needed to address the most pressing impacts meaningfully[118], and some countries have begun working towards such a systemic transformation. Examples include Food Vision 2030, Ireland's stakeholder-led strategy for the agri-food sector. This includes measurable targets and enhanced implementation and monitoring through the so-called high-level implementation committee chaired by the country's minister for agriculture, food and the marine. Meanwhile, the Austrian Service Agency for Sustainable Food and Nutrition Systems supports the interministerial collaboration related to food systems, and Finland is preparing a long-term food strategy for a sustainable and viable food system.

More country examples of national, regional and local measures and actions towards a more sustainable food system can be found in the country profiles of *Europe's environment 2025*.

Awareness of the environmental and climate impacts of food waste has increased over time, and if the revised waste framework directive is adopted in autumn 2025, legally binding food waste targets will apply to EU Member States[119]. An early example of policy-driven action is France's law regarding food waste and the circular economy. Implemented in 2020, it has introduced national targets and a certification system (See Box 5.12).

Box 5.12

France's fight against food waste: a national and local success story

France has become a leader in combating food waste through a blend of strong national legislation and dynamic local initiatives, aiming to reduce food waste significantly across the entire food supply chain. This multi-level approach fosters systemic change across the entire food value chain.

The anti-waste for a circular economy law sets out clear, measurable objectives: a 50% reduction in food waste by 2025 for the food distribution and mass catering sectors, and by 2030 for food production, processing, consumption and commercial catering, all relative to 2015 levels. It enshrines a legal definition of food waste and prohibits the destruction of edible food, mandating that unsold but consumable food be redistributed, often via donations to food aid organisations. It also introduces a voluntary anti-food waste certification for the distribution, collective and commercial catering and food processing sectors, setting maximum rates of waste generated to receive three levels of certification.

At the local level, regional networks bring together stakeholders from every part of the food system, including producers, processors, distributors, local authorities, civil society organisations and consumers. Their goal is to foster collaboration, promote best practices, co-develop projects and build collective knowledge to tackle food waste at the local level.

This combination of top-down legislation and bottom-up engagement illustrates how multi-level governance can address systemic sustainability challenges. The law provides regulatory clarity, legal pressure to adhere to standards and national accountability. Meanwhile, the national anti-food waste certification and regional networks channel this momentum into action that is grounded, inclusive and adaptable.

See France's country profile for more information on national action to increase the sustainability of the food system.

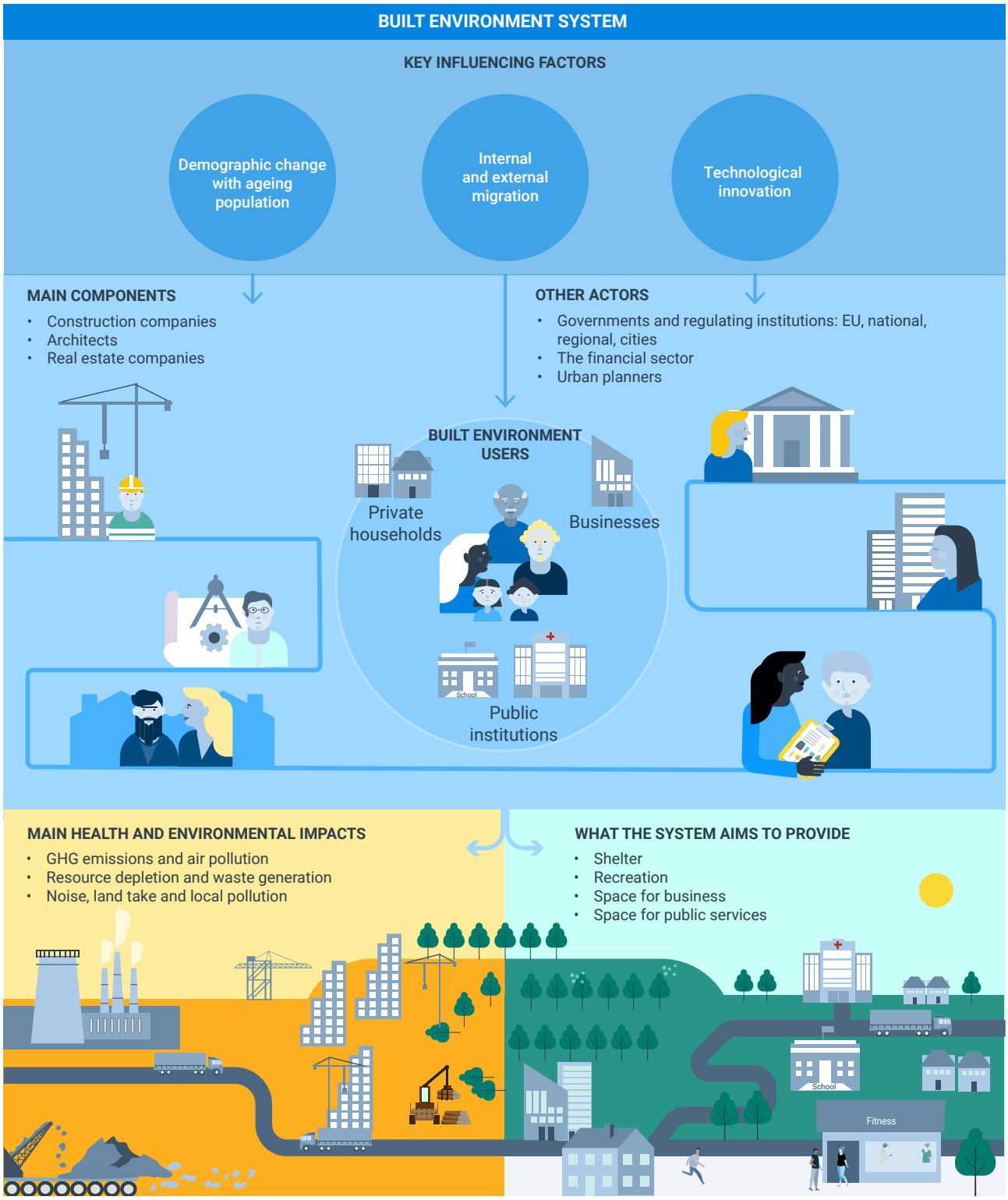
At the same time, food insecurity remains an issue for 1 in 10 residents in Europe[120]. Despite the overall abundance of food in Europe, access to nutritious food remains uneven, with low-income populations particularly vulnerable to food insecurity. Economic disparities, rising food prices and economic challenges threaten access to nutritious food, exacerbating health inequalities. To ensure food security for all, these disparities need to be addressed through social policies, food assistance programmes and efforts to reduce food prices.

The food system relies on some of the socio-economic sectors most sensitive to climate change since changes in temperature and precipitation are already influencing crop yields, fish stocks, livestock productivity and the availability of water for irrigation[121], livestock and food processing[122,123]. Besides all other issues stemming from nature degradation, the resulting economic and financial risks now represent key issues also for financial institutions, whose strategies should from now on unequivocally support and complement the policy initiatives that support nature restoration[124].

More information on Europe's agriculture, fisheries and the food system is available here, in Chapter 3 sections 3.4.1, 3.4.2 and 3.4.3 on drivers and pressures and in the briefings 'Land use and land take' and 'Soil resources'.

5.5 Built environment system

Figure 5.8 The built environment system



Source: EEA, 2025.

5.5.1 Systems-level EU policies

The built environment is a significant nexus for environmental and climate impacts as, either directly or indirectly, it is responsible for more than 30% of Europe's environmental footprint. For this reason, the built environment is subject to a wide network of policy initiatives at the EU level addressing systemic challenges.

The energy performance of buildings directive calls for a fully decarbonised building stock by 2050, while the renovation wave aims to double the annual renovation rate by 2030 in order to improve the energy efficiency of buildings. Construction product sustainability is regulated by the construction products regulation, while the new EU ETS2 will address GHG emissions from the housing sector by focusing on fuel distributors from 2027 onwards. At city level, the Urban Agenda for the EU provides a multi-level working method for urban policy and practice.

Besides the tailored legislative initiatives — and due to its significance in terms of environmental impact — the built environment features in broader EU initiatives such as the EU Adaptation Strategy; this includes, amongst its objectives, the aim to embed awareness of adaptation and planning in 'every single local authority, company and household' by 2030. The EU's Biodiversity Strategy for 2030 focuses on promoting healthy urban ecosystems and the NRR calls for nature-based solutions and urban green spaces.

5.5.2 Progress and challenges

Europeans spend on average around a quarter of their income on housing, mainly on renting or buying homes or on paying bills, for example for electricity and heating. Constructing buildings and supplying them with energy or water supply services puts pressure on the environment. Buildings are responsible for 42% of the EU's annual energy consumption, 35% of annual GHG emissions — including both direct emissions in buildings and indirect emissions from heat and electricity use — and around one-third of all materials consumed annually in the EU. At the same time, buildings are a EUR 1.7 trillion industry[125], directly providing more than 18 million jobs[126].

Energy consumption in buildings dropped by almost 8% between 2005 and 2022[127] but energy efficiency needs to be accelerated significantly if the EU is to achieve its policy targets. Building renovation and changes in cooling and heating systems have been targeted as the main vehicles for reducing the energy consumption of households and are supported by significant financial mechanisms (e.g. the Recovery and Resilience Facility).

Europe has some of the oldest city centres in the world, with 42% of all buildings built before 1950. In this context, buildings are not necessarily adapted to current or future climate conditions. Rising temperatures combined with an ageing population mean that more people are becoming more vulnerable to heat. Buildings as long-lasting structures can offer protection from heatwaves and high temperatures if appropriately designed, constructed, renovated and maintained. Other initiatives are addressing this increasing problem with innovative, inclusive and collaborative solutions (See Box 5.13).

Box 5.13

Tackling summer energy poverty through community action: the Cooltorise Project

With climate change driving more frequent and intense heatwaves, Europe faces a growing challenge: summer energy poverty. Once linked mainly to winter heating, energy poverty now also means being unable to stay cool. Around 19% of EU households report struggling to keep homes comfortable in summer, threatening health, well being and equity.

Launched in 2021 and funded by the EU Horizon 2020 programme, Cooltorise is the first European initiative targeting this issue. Active in Bulgaria, Greece, Italy and Spain, it has reached over 3,500 households with support from 55 partners. Its goals are to improve thermal comfort, cut energy use and raise awareness around energy use for cooling over the summer months.

At its core is a community based approach, engaging local groups and residents through 400+ activities. These target vulnerable groups — older adults, single mothers, migrants and low income households. Trained summer energy poverty agents combine technical and social skills to work effectively with diverse communities.

Workshops are central. 'Heat culture' sessions teach passive cooling methods — shading, ventilation and behavioural changes — while exchanging traditional coping strategies. 'Bill optimisation' workshops boost energy literacy, helping residents understand utility bills, avoid overcharges and access social tariffs. Cooltorise also distributed summer relief kits, supported climate shelters in public spaces and promoted gender equity, recognising that energy poverty disproportionally affects woman. 'CoolKids' workshops helped to engage children and enable the participation of mothers.

Challenges that affect people's capacities to tackle energy poverty include language barriers and digital exclusion, with the provision of multilingual materials, outdoor venues and child friendly activities identified as solutions.

By focusing on education, empowerment and cooperation rather than costly infrastructure, Cooltorise has improved comfort, reduced bills and fostered social cohesion. It shows that local, inclusive action can advance both climate adaptation and energy justice, ensuring that vulnerable people are protected in a warming world.

Direct GHG emissions from EU buildings decreased by 35% between 2005 and 2023. This progress was driven by higher energy efficiency standards for new buildings, energy efficiency improvements in existing buildings, decarbonisation of the electricity and heating sectors, as well as warmer temperatures. However, in 2021, emissions rebounded, partly due to a colder winter and economic recovery from the COVID-19 pandemic. Over the longer term, the trend towards declining emissions is expected to continue but a substantial acceleration in energy renovations is needed to reach the EU's 2030 targets[128].

Energy efficiency is expected to improve in the future, thereby reducing GHG emissions from buildings in use. Due to this reduction, there is an expectation that the embodied energy and carbon in building materials and components will become a more significant focus. Currently, such emissions represent around 20-25% of total lifecycle emissions from buildings, but their share is expected to increase mainly due to improvements in energy efficiency in buildings in use[129]. Lifecycle tools such as the Level(s) framework for assessing buildings' sustainability can help assess impacts from embodied energy and carbon, and avoid trade-offs. Selecting low-carbon materials for new construction or renovation is key to reducing buildings' whole life carbon emissions.

From a financial perspective, many EU instruments under the Multiannual Financial Framework (MFF) 2021-2027 channel resources to cities, local authorities and regions, and target also buildings specifically (e.g. for renovation). These include the LIFE programme, the Interreg Europe and Interreg NEXT, Horizon Europe — the EU's research and innovation funding which covers the EU Mission on Climate-Neutral and Smart Cities — and the New European Bauhaus initiative launched in 2021, to foster sustainable solutions for transforming the built environment and lifestyles under the green transition.

Despite this increased focus on urban adaptation to climate change in the built environment and the role that land plays in mitigating its impacts, trends remain poor for land take and soil sealing. Between 2012 and 2018, land take in functional urban areas of the EU-27 increased significantly, mostly at the expense of croplands and pastures, with significant impacts. While there is no legally-binding policy target in relation to land take and soil sealing at the EU level, the new EU Soil Strategy for 2030 calls on Member States to set land-take targets for 2030, with the aim of reaching land-take neutrality by 2050[130].

Furthermore, Europe continues to see the development of housing in flood and wildfire risk areas, as well as areas affected by water scarcity. For example, 41% of the EU population was affected by water scarcity conditions in 2022[131]. Between 2011 and 2021, 12% of Europeans lived in potential riverine flood-prone areas and 935,000 people moving into potential riverine flood-prone areas[132].

It is estimated that more than 85% of the European building stock required for 2050 already exists today[133]. Therefore, to achieve EU policy targets, the current built environment must be transformed. Renovation that increases energy efficiency and prioritises climate change adaptation and circularity is the way to make the built environment fit for 2050. New construction and renovation need to adopt circularity principles so to lower demand for new resources as well as waste.

More information on Europe's built environment system can be found here, on urban sustainability here and in Chapter 3 sections 3.1.4, 3.2.4 and 3.3.4 on drivers and pressures.

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6 A cause for hope: levers of transformative change

Key messages

- Transformative change to our systems of production and consumption — decarbonising the economy, shifting towards circularity and exercising responsible stewardship of natural resources — is necessary to maintain living standards in Europe over the long term. EU policies to cut greenhouse gas emissions provide an example of how ambitious, coherent and directional policies that send consistent signals across the economy can drive systemic change.

- Legislation to protect nature and the climate was significantly strengthened under the European Green Deal, with Member States now focused on implementing and enforcing new requirements.

- Local and regional authorities are playing a critical role in implementing environment and climate legislation and successfully translating policies into change on the ground, with a growing body of practical examples taking shape across Europe.

- Environment and climate legislation has impacted European businesses, with evidence of first mover companies shifting from a conventional approach of compliance with minimum standards to a reinvention of their business models to prioritise decarbonisation and circularity.

- Technological innovation is key to changing the dynamic between our economy and nature. To deliver change, the scale up and deployment of cleantech must accelerate well beyond the current trajectory, with financial support needed for pilot and demonstration phases. Key technologies include batteries, carbon capture utilisation and storage, renewable hydrogen and solutions for the electrification of hard-to-abate sectors.

- The transition to a decarbonised and more circular economy will result in significant job creation in strategic sectors. Boosting employment will depend on targeted skills development in education and training policies to align the labour market with business needs.

- Public and private investment flows must be increased and reoriented towards sustainability objectives. Clear regulatory signals reinforced with consistent pricing can make low-carbon and circular choices cheaper, with the phase-out of fossil fuel subsidies crucial to decarbonisation.

Introduction

A new dynamic between people and nature can create jobs, support health, and foster social fairness and prosperity[1]. Circularity and decarbonisation offer a pathway towards a competitive and resilient economy that is less dependent on imports of materials and energy, and therefore less vulnerable to external shocks and geopolitical instability. Resilience to climate change must be built into our economy, our financial system and our cities to ensure a secure and prosperous future for European citizens.

This chapter considers how to enable change in our use of natural resources. It builds on examples of successful policies at the EU level and case studies drawn from the European Environment Agency's (EEA's) European Environment Information and Observation Network (Eionet) of approaches implemented at the national, regional and local levels. A range of levers can be used to shift the dynamic between nature and our economy (see Figure 6.1). Change can be driven by coherent mixes of policies that send consistent signals both vertically through the multiple layers of governance as well as horizontally across policy domains. Effective implementation and enforcement, as well as building public acceptance through participatory measures, are also key to policy success.

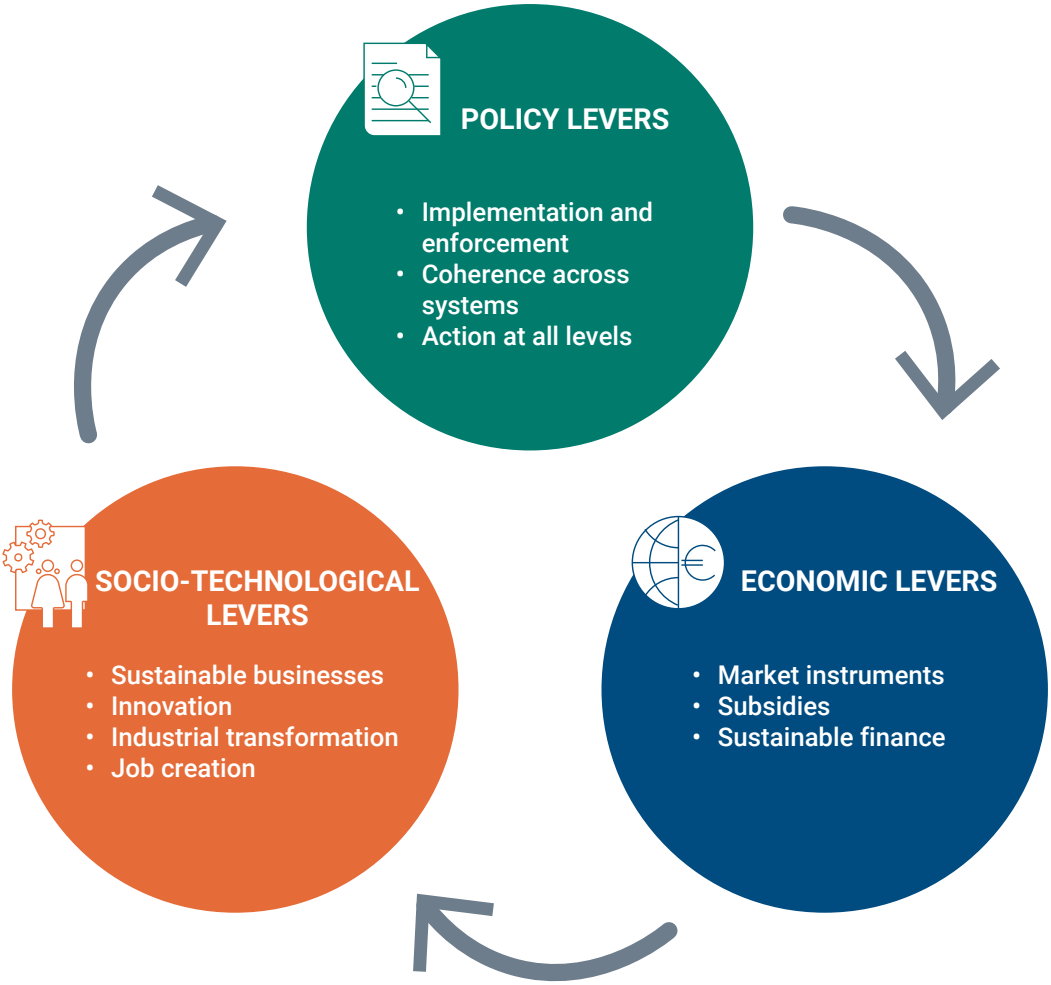
The key levers of the socio-technical environment that business and industry operate in include pressure on business to adopt sustainable models and accelerate the transformation of European industry through legal requirements, carbon pricing, transparent sustainability reporting and demand-side measures. Efforts to harness both technological and social innovation are considered, as well as the growth in green employment and good practice in fostering the development of green skills in the labour market.

In terms of the economic levers for change, there is a need to reorient investment towards sustainability, with a range of solutions on the table to increase the contribution from private capital. Examples show how green taxation and economic instruments, such as carbon pricing, can make sustainable business models and products economically attractive and accelerate the uptake of new technologies and practices. Eliminating fossil fuel subsidies is also crucial to enabling decarbonisation.

The focus on short-term gain inherent to our current financial system sits in profound contrast to the long-term goal of delivering sustainable prosperity. Recognising this tension, financial institutions are starting to take a strategic, forward-looking approach to considering climate-related and environmental risks.

The report closes by highlighting how securing Europe's natural capital creates the conditions for prosperous future for Europe, where people benefit from quality jobs, resilience to climate change and sustainable supplies of food, water, energy and goods.

Figure 6.1 **Policy, socio-technological and economic levers for transformative change**



Source: EEA, 2025.

6.1 Policy levers for transformative change

6.1.1 Effective implementation and enforcement

Legislation to protect nature and climate has been strengthened significantly under the European Green Deal (EGD), with Member States now focused on implementing and enforcing new requirements and standards in a range of areas, from nature protection to air quality and energy efficiency.

As reported by the European Commission (EC) in their Communication on 2025 Environmental Implementation Review (Box 6.1), an implementation gap persists, with the need to accelerate progress to reduce damages and costs. The EC found that:

> because of the implementation gap in the field of EU environmental law, the EU is currently incurring large costs of non-implementation such as premature deaths – one in ten deaths in the EU can be linked to pollution – the cost of disease, including healthcare costs and lost productivity, cleanup costs, and reduced ecosystem services[2].

A 2025 study found that the cost of failure to fully implement EU environmental law and policy amounts to at least EUR 180 billion a year[3].

The Communication recognises environmental protection as a matter of security, building resilience against environmental disasters and risks – such as floods, droughts, fires, and zoonotic diseases – as well as protecting the EUR 234 billion of ecosystem services that nature currently provides to our economy. In addition, it points to high environmental standards as a driver of private sector innovation in the EU cleantech sector, identifying environmental policy as a key factor in the competitiveness of the EU's economy[2].

Failed or weak implementation means that environment and climate impacts persist, public trust is undermined, and businesses compete on an uneven playing field. To address some of these issues, the environmental crime directive was adopted in April 2024 with the aim of deterring severe breaches of EU environmental law and combatting environmental crime more effectively.

Box 6.1

Environmental Implementation Review

Responsibility for the implementation of EU environmental law and policy sits primarily with the Member States. The EC provides support through political and technical dialogues, guidance on the legal interpretation, EU financing and technical assistance. Where necessary, the EC takes enforcement action through infringement cases.

The Environmental Implementation Review (EIR) is an additional tool to monitor and support implementation. The report takes stock of the current state of implementation of EU law and policy in the Member States. It identifies good practices and challenges in the Member States and recommends improvements and solutions, as well as priority actions for each Member State.

The 2025 EIR includes a communication on EU-wide trends, and 27 reports on the state of implementation in each Member State, as well as an interactive map on pending environmental infringement cases.

The Communication on the 2025 EIR identifies five key factors that make the difference between good implementation and poor implementation, namely:

1. the integration of environmental objectives in public policies, through political dialogues and choices on sharing the implementation cost among stakeholders;
2. financing;
3. administrative capacity, especially to ensure proper planning and coordination;
4. digital data; and
5. the role of public participation in environmental decision-making and access to justice.

The EU's air quality policies provide a positive example of success in tackling an environmental risk to health, reducing the cost in human lives and economic losses to air pollution. As a good example of the successful implementation of EU policies at the local level, Box 6.2 describes measures to address air pollution in Poland.

Box 6.2

Anti-smog measures in the Małopolska region of Poland

Southern Poland is one of the most polluted regions in the EU. In Małopolska, air quality has been particularly poor during winter months, with concentrations of particulate matter (PM_{10} and $PM_{2.5}$) and benzo(α)pyrene (BaP) exceeding EU air quality standards. The main source of pollution was coal boilers used for residential heating, while road traffic also contributed to exceedances of nitrogen dioxide.

With the aim of reducing air pollution, the authorities in Małopolska introduced an air quality plan in 2009, which they update regularly. In 2016, the city of Kraków adopted an anti-smog resolution banning solid fuels from 2019. Measures put in place at the regional level complemented this by requiring the gradual phase-out of old coal boilers by 2026. To support households, programmes were launched to replace outdated coal boilers and modernise heating systems. These efforts were supported by an EU LIFE Project and the National Fund for Environmental Protection and Water Management, as well as awareness-raising campaigns.

Between 2017 and 2024, more than 111,000 coal and wood boilers were replaced with gas-fired boilers, district heating, electric heating, heat pumps, oil-fired boilers and eco-design solid fuel boilers. However, around 115,600 old boilers remain in use outside Kraków, including about 62,000 that serve as the only heating source. Replacement rates varied by municipality, with non-governmental organisations playing an important role in supporting the anti-smog resolution.

As a result of these measures, air quality has markedly improved since 2019, with the latest provisional data from 2024 showing significant progress in cutting pollution.

- For $PM_{2.5}$, in 2018, almost all monitoring stations in the region registered concentrations above the EU limit value of 25 µg/m^3. In contrast, in 2024, no exceedances of limit values were recorded at any of the stations.
- For PM_{10}, in 2017, all the monitoring stations in the region registered values above the EU daily limit value. In contrast, in 2024, only three stations exceeded the EU daily limit value.
- For BaP, concentrations have been cut by more than half, although they remain above the EU target value.

Despite the positive impact of the anti-smog measures in improving air quality, it should be noted that concerns about elevated levels of air pollution in this region remain. Significant further reductions are needed to meet EU air quality limit values, which entered into force in 2005 but were still exceeded in the Małopolska region in 2023 (the latest year for which validated data has been reported).

The importance of ensuring that the costs of policies are fairly distributed and that regressive impacts on vulnerable groups are avoided became apparent during the series of protests led by farmers in Brussels and across European Member States in late 2023 and 2024[4]. Looking ahead, the EC's current priorities place increased emphasis on social fairness. Such initiatives include the roll-out of the Social Climate Fund, the Just Transition Mechanism, and the first EU Anti-Poverty Strategy, foreseen for 2026.

There are complex reasons why policy implementation can fail. The Joint Research Centre (JRC) recently brought together representatives of ministries responsible for horizontal public administration policies and coordination services from across Member States to identify key obstacles to implementing the EU's green policies.

The key barriers included a lack of political will, insufficient resources and infrastructure, limited awareness and expertise, public resistance to change, governance complexity, as well as business resistance and lobbying[5].

In this context, Box 6.3 considers the progress of Member States towards the EU's waste targets and identifies the key factors seen as contributing to their success.

Box 6.3

The early warning mechanism on waste targets

The waste framework directive, landfill directive and packaging and packaging waste regulation mandate the EC, in collaboration with the EEA, to assess Member States' prospects of meeting recycling and landfill targets for municipal and packaging waste 3 years ahead of the target years (2025, 2030 and 2035). The first early warning assessment identified nine Member States that were likely to meet both the 2025 recycling targets for municipal waste and total packaging waste and 18 Member States at risk of missing the recycling target for municipal waste. Of those, eight were also at risk of missing the recycling target for total packaging waste[6,7] (see briefing 'waste recycling').

Analysis of the key factors influencing performance points to the importance of:

- proper separate collection and treatment systems for biowaste, which usually forms the largest fraction of municipal waste;
- bans or taxes on the landfilling of (biodegradable) municipal waste; and
- economic incentives for citizens to sort their waste (e.g. pay-as-you-throw collection fees).

Achieving high recycling rates and reducing landfilling usually also requires the combination of several policy instruments and good monitoring[8].

The EC issued policy recommendations for all Member States at risk of missing the targets in its early warning report[7] and held dialogues with relevant authorities. A similar process was organised for the three EEA-European Free Trade Association (EFTA) states by the EFTA Surveillance Authority[9].

Recent analysis indicates that several Member States have stepped up their efforts to collect biowaste separately, and several have introduced or increased landfill taxes since the publication of the early warning report[10].

6.1.2 Coherent policies across systems

To drive transformative change, packages of policies should provide clear and consistent direction across systems. Coherent policy mixes can provide directionality alongside appropriate systems of incentives and disincentives. Key enablers are necessary, including market-based instruments, regulatory signals and incentives, as well as effective enforcement procedures.

Systems of incentives in place for economic sectors that run counter to environment and climate goals can derail implementation; this is the case with subsidies for fossil fuels that lower the price of fossil-based energy against renewables. Aligning market signals with regulatory goals can make sustainable choices affordable and attractive to businesses and consumers. For example, in the food system, the Common Agricultural Policy (CAP) and Common Fisheries Policy (CFP) need to

align with climate and environment goals to foster transitions in food production and consumption[11]. It is crucial that the Vision on Agriculture and Food, the next CAP and the CFP are coherent in terms of how they address biodiversity and climate objectives.

EU climate policies provide an example of an ambitious, coherent and directional policy package that has successfully delivered significant cuts to greenhouse gas (GHG) emissions. The EU Emissions Trading Scheme (ETS) system has priced carbon emissions and made polluters pay, while the Social Climate Fund will address social impacts and revenues channelled to support the decarbonisation of European industry (see Box 6.4).

Box 6.4

The EU Emission Trading Scheme

The EU ETS requires polluters to pay for GHG emissions. Launched in 2005, it is the world's first carbon market, bringing down EU emissions while generating revenue to finance the green transition through a 'cap and trade' system. It covers emissions from electricity and heat generation, industrial manufacturing and aviation; these account for roughly 40% of total GHG emissions in the EU. By 2023, the EU ETS had helped to decrease emissions from European power and industry plants by approximately 47% compared to 2005 levels[12].

Under the 2023 revision of the ETS directive, ETS2 will address CO_2 emissions from fuel combustion in buildings, road transport and additional sectors where emission reductions have been insufficient to put the EU on a firm path towards its 2050 climate neutrality goal. The ETS2 will complement other sectoral policies, helping Member States achieve their emission reduction targets under the effort sharing regulation (ESR). The carbon price set by the ETS2 will also provide a market incentive for investments in building renovations and low-emission mobility.

The ETS2 will become fully operational in 2027, covering upstream emissions. Fuel suppliers, rather than end consumers such as households or car users, will be required to monitor and report their emissions. These entities will be required to surrender sufficient allowances to cover their emissions. Regulated entities will purchase these allowances at auctions. The ETS2 cap will be set to bring emissions down by 42% by 2030 compared to 2005 levels.

The Social Climate Fund will address the social impact of carbon pricing in the sectors covered by the ETS2 by supporting households in energy or transport poverty. The Fund will mobilise EUR 86.7 billion from ETS2 revenue in the 2026-2032 period. Under Social Climate Plans, Member States may choose to support structural measures and investments in energy efficiency and building renovation, clean heating and cooling and the integration of renewable energy, as well as zero- and low-emission mobility solutions. They may also provide groups with temporary direct income support.

ETS revenues also flow to the EU Innovation Fund, which aims to bring to the market solutions to decarbonise European industry while fostering its competitiveness. Funding flows to projects focus on innovative low-carbon technologies and processes in the following areas:

- energy-intensive industries;
- carbon capture and utilisation (CCU);
- construction and the operation of carbon capture and storage (CCS);
- innovative renewable energy generation; and
- energy storage in sectors covered by the ETS and ETS2.

Achieving systemic change entails trade-offs across public priorities, thereby impacting multiple societal actors, including businesses and civil society[13]. The Council recommendation on ensuring a fair transition towards climate neutrality provides an example of a comprehensive multi-actor approach to guide Member States in developing just transition strategies[14]. Given that policies impact people's lives, public engagement and participation are critical across governance levels and sectoral areas. Finland's efforts to balance ambitious climate action with social fairness are described in Box 6.5.

Box 6.5

The Finnish model for balancing climate action with social fairness

Finland aims to be the first carbon-neutral welfare state by 2035, integrating social and regional fairness into its climate policies. The country's approach embeds justice principles into legislation and includes practical measures to ensure equitable climate action. The Finnish Climate Act sets GHG emission targets for 2030, 2040 and 2050. It defines a just transition as minimising negative impacts on employment, social participation and regional development while addressing income disparities and ensuring intergenerational fairness.

The Act recognises the Sámi people, Finland's only indigenous group, as vulnerable to climate change. It involves them in climate governance through the Sámi Parliament and established the Sámi Climate Council to draw traditional knowledge into the debate.

Plans to implement the act were informed by a comprehensive consultation process that assessed the social distribution of the impacts of proposed measures. It evaluated their effects on income distribution, especially for vulnerable groups such as the elderly, children, people with disabilities and the Sámi.

Using EUR 466 million from the EU Just Transition Fund, Finland supports regions affected by the phase-out of peat production, aiming to diversify economies, boost employment, and provide training and re-skilling for workers, especially for youth. The plans also promote peatland restoration[4].

More broadly, recent geopolitical shocks have made concepts like anticipation, foresight, preparedness, responsiveness and resilience more central to governance systems in Europe. The Niinistö report *'Safer together: A path towards a fully prepared Union'* concluded that strengthening Europe's preparedness for security challenges, such as climate change and increasing natural disasters, is a matter of urgency. The report called for a profound change of mindset, and a shift in the way we understand and prioritise preparedness across the EU[15]. The EU Preparedness Union Strategy aims to bolster foresight and anticipation capabilities, including by developing a comprehensive risk and threat assessment at the EU level. The Strategy calls for an integrated all-hazards approach (preparing for and responding to all types of hazards, rather than addressing them separately), a whole-of-government approach (bringing together all relevant actors across all levels of government) and a whole-of-society approach (bringing together citizens, local communities and civil society, businesses and social partners, as well as the scientific and academic communities)[16].

6.1.3 Action at local and regional levels

Delivering systems change requires coordinated policies and action across multiple levels of governance, including European, national, regional and local authorities. The European Committee of the Regions highlights the critical role of local and regional authorities in urban and regional settings, whereby 70% of climate change mitigation and 90% of adaptation initiatives are executed at the municipal and regional levels[17].

At the national level, the EU model of governance is guided by the principles of 'subsidiarity', 'proportionality' and 'partnership', with the aim of ensuring that appropriate, place-based decisions are made. For example, the EU's ambitions to decarbonise the transport sector require comprehensive national strategies to curb mobility, shift to public transport, promote more active means of transport, and support renewable-based electrification, including electric vehicles[18]. In terms of action on circularity, 24 Member States have voluntarily developed circular economy strategies, roadmaps or action plans that complement EU policies (see briefing 'circular economy financing and strategies').

Local governments are responsible for urban planning and for maintaining complex urban infrastructure and are often responsible for education, health and housing. Thus, they can develop solutions adapted to local populations and be effective agents of change. For example, rethinking mobility and implementing sharing economies have been made possible by the compact nature of cities and the high density of users. Community-led energy projects — such as prosumerism and energy cooperatives — have enhanced local engagement and investment in renewable energy[19].

Examples of citizen engagement include participatory budgeting and youth councils that work towards intergenerational justice, as well as processes to assess the distribution of costs and benefits of policy proposals across social groups. For this level of participation to become standard, regional and local authorities need support for capacity-building and resources. Evidence from climate adaptation shows how the active involvement of all stakeholders — from planning through to implementation — fosters legitimacy and success[20].

The impacts of climate change can be even more intensely felt in urban areas due to their morphology and their dense infrastructure and high population. Adaptation is required across all sectors and at all governance levels. Good adaptation governance essentially means effective coordination of planning and implementation, as well as resources, both horizontally (across different sectors and departments) and vertically (across all administrative levels)[20]. Authorities need new capacities to identify and manage systemic risks, including collaborative structures that involve multiple stakeholders and facilitate information-sharing and collective action[21].

Countries in Europe have made considerable progress in developing and planning policies to adapt to climate change. However, there is an urgent need to increase the pace and scale of adaptation actions to prepare adequately for the risks ahead. The EEA's European Climate Adaptation Platform, Climate-ADAPT, provides a pool of practical examples of adaptation measures. These measures have been applied at different governance levels and in different policy sectors across European countries and can facilitate peer-to-peer learning. Two examples of good governance in climate change adaptation measures are presented in Box 6.6.

Box 6.6

Examples of good governance in climate change adaptation

Implementation of the landscape and watershed recovery programme in the Košice region of Slovakia led to the creation of six independent water and land restoration advisory boards. The new governance setting entailed a holistic cross-sectoral approach that promoted community engagement, involving municipalities, universities, farmers, landowners, volunteers and activists. The programme aims to reduce runoff, mitigate floods and counteract drought and heat waves, through the construction of water retention structures in forests, agricultural land and cities[22].

Under the evolving regions project, seven rural districts in the German Federal state of North Rhine-Westphalia adopted a multilevel governance approach to adaptation, mixing bottom-up and top-down approaches. The collaborative approach empowered rural communities to effectively implement the Federal State Adaptation Law, thereby helping 100 municipalities with nearly 2.4 million inhabitants to prepare for climate change[23].

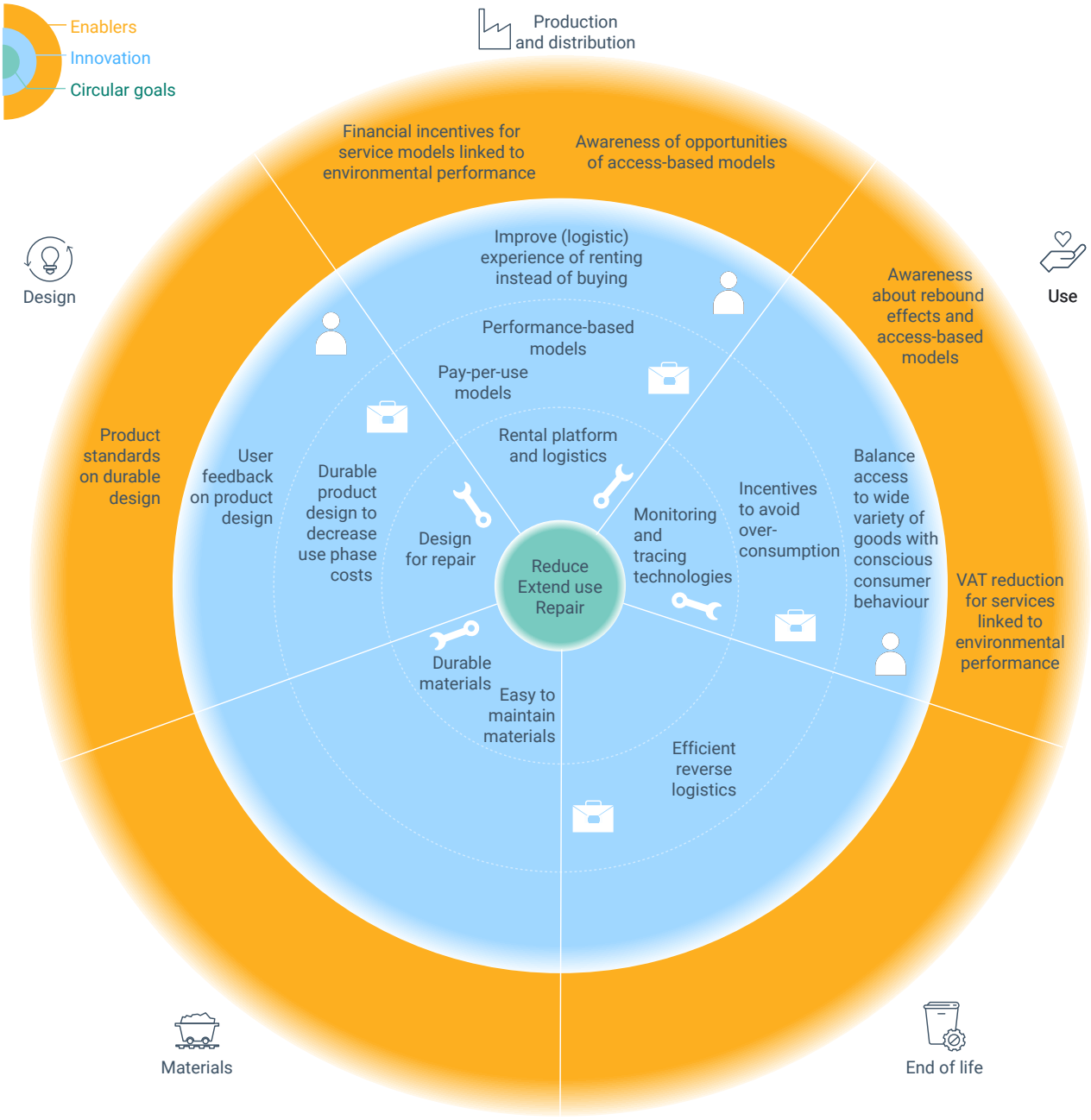
6.2 Socio-technological levers for transformative change

6.2.1 Fostering sustainable business models

EU environment and climate policies have transformed the operating environment for European businesses, while climate change affects supply chains and creates risks of stranded assets[24]. A challenge for companies is to create value in this new environment, shifting from a conventional approach of compliance with minimum standards to a reinvention of the business model[25]. This involves embracing new principles such as sufficiency, circularity, systems thinking, a redefinition of value, equity and justice[26]. At the same time, European businesses are embedded in the global economy where competition impacts the viability of business models; they must perform economically and create jobs while shifting towards sustainability.

Europe's transition to circularity has profound implications for business models tightly bound to upstream supply chains and downstream consumption and use. For example, new business models based on renting and sharing goods and services demand a rethink of how to create value. Figure 6.2 provides examples of business models based on access to services rather than product ownership.

Figure 6.2 **Strategies for access-based business models to increase circularity within the product chain**



Source: ETC WMGE[27].

For example, car-sharing is a mobility innovation that offers access to cars on an as-needed basis, responding to the fact that private cars currently stand idle 95% of the time[28]. Car-sharing decreases distance travelled by car and GHG emissions, with the greatest benefits from electric vehicle fleets[29]. However, growth in car-sharing has been slow, with operators facing high operating costs and challenges in ensuring the availability of vehicles and parking spots for consumers[30]. Making the new business model profitable requires shifts in technology, as well as in consumer expectations and behaviour. A Dutch study found car-sharing to be successful when the technology is coupled with efforts by authorities to reduce private car ownership, for example by limiting parking for private cars[28].

The cooling and refrigeration industry is also steadily evolving to meet the demands of a low-carbon future. A key driver of this transformation is the Kigali Amendment to the Montreal Protocol, a global agreement that mandates the phase-down of hydrofluorocarbons — potent GHGs commonly used in air conditioning and refrigeration systems. By establishing clear, legally-binding targets, the Kigali Amendment provides the industry with long-term regulatory certainty, enabling companies to invest confidently in the development and deployment of alternatives with lower climate impacts. This predictability is crucial for fostering innovation, scaling up sustainable technologies, and ensuring a smooth transition across global markets. The amendment not only aligns environmental goals with business development but also reinforces international cooperation, ensuring a level playing field for all countries to move forward together in reducing the climate impacts of cooling and refrigeration. A similar approach was applied from the early 1990s onwards when ozone-depleting substances were phased out in the cooling and refrigeration industry.

With a supportive regulatory environment, businesses can redesign products and services with durability, reparability and recyclability in mind, minimising waste and optimising material flows(31). Indeed, reducing material resource use and better use of secondary materials may be a solid strategic response to decrease reliance on volatile supply chains(27).

The Circular X project provides tools and methods to support companies in their transition towards circularity. It also provides a database of case studies of business models, circular economy strategies and experimentation practices. Documented benefits include cost savings, finding new revenue streams and first-mover advantages.

A recent study assessed 84 'regenerative business cases' from 15 sectors and found the food, consumer goods and fashion sectors to be the most innovative(32). For the textiles system, as an example, options to include circularity include:

- ensuring the longevity and durability of products;
- access-based models, such as renting clothing;
- textile collection and resale;
- recycling and reusing materials(33).

The policy framework for textile waste is changing. There is a plan to develop ecodesign requirements under the ecodesign for sustainable products regulation and textile waste collection has been mandatory since January 2025. Negotiations are also ongoing on creating an extended producer responsibility system for textiles and on banning the destruction of unsold textiles. At national level, France has recently taken action to curb the environmental and social impacts of ultra-fast fashion (see Box 6.7).

Box 6.7

French action to tackle the environmental impacts of ultra-fast fashion

France has introduced pioneering legislation to reduce the environmental impacts of fast fashion, a model characterised by rapid clothing production and turnover. This leads to environmental impacts including high water consumption, chemical pollution, microplastic release from synthetic fibres and waste generation. The law targets the excessive release of 'new collections', and aims to encourage more sustainable consumption and production in the textile industry through three actions.

1. It defines ultra-fast fashion as the release of a high number of new products within short timeframes, often without incentives for repair or reuse. The definition sets the base for legal thresholds to limit the release of new collections.

2. It mandates greater transparency when thresholds are surpassed, empowering consumers to make sustainable choices, and bans advertisements for ultra-fast fashion products.

3. It strengthens the Extended Producer Responsibility by requiring producers, importers and distributors to make payments based on their environmental footprints, with penalties reaching up to EUR 10 per item by 2030.

In electronics, while efforts to date have focused heavily on improving energy efficiency this is changing slowly with an increasing number of requirements for circularity (see briefing 'circular design and sustainable production'). At the same time, there are some signs that product lifespans for mobile phones, tablets and flat screen TVs are increasing slightly[34]. However, electronics quickly become obsolete due to fast-moving innovation. Additionally, the market demand for ever-improving performance is high. In a context where global supply chains are opaque, reducing the EU's reliance on imported components and materials, and increasing the recovery of secondary materials and the reuse of components could reduce the impacts of material extraction and processing[35].

Businesses are also playing a role in the early stages of the shift to a sustainable food system. The food service sector is well-positioned to catalyse the transition to healthier, more sustainable diets by encouraging customers to choose plant-rich dishes when dining out using a range of behaviour change techniques[36].

The Eat-Lancet Commission provides a set of recommendations for food service professionals on how to shift food culture towards their 'planetary health diet'[37]. A recent review of business models for sustainable food emphasised the importance of collaborative approaches, a clear vision of sustainability, company values and ongoing innovation. Enablers include stakeholder engagement and cooperation within the value chain as well as marketing to increase consumer awareness. The three most common business models were found to be place-based social food networks, circular business models targeting zero agri-food waste and disruptive models — such as switching to plant-based protein or alternative distribution chains[38].

Looking upstream, examples of nature-positive business models in agricultural and forestry include restoring degraded forests, regenerative practices to improve soil health and agricultural production, producing and marketing sustainable food, and reducing food waste[39].

Realistically, most businesses will only redesign products and services towards circularity either if it is a legal requirement or if it is profitable. Subsidies for green products, taxes on unsustainable products and access to markets where consumers pay more for sustainable products all offer pathways to profitability. Policies that can direct corporate innovation towards circularity include measures to increase product lifetimes, expand green public procurement and improve secondary materials markets[27].

The Clean Industrial Deal aims to stimulate demand for low-carbon products and create lead markets for European clean technologies and products, with the EC planning to review the public procurement framework in 2026 to introduce sustainability, resilience and European preference criteria in public procurement for strategic sectors. In addition, the initiative for an Industrial Decarbonisation Accelerator Act foresees the development of an EU label on the carbon intensity of industrial products. It will also introduce sustainability and resilience criteria and minimum EU content requirements in public (and in some circumstances, private) procurement in strategic sectors. The ecodesign for sustainable products regulation foresees the introduction of mandatory green public procurement requirements for certain product groups.

Given that public authorities are among the largest buyers of goods and services — with public procurement accounting for up to 14% of EU Gross Domestic Product (GDP)[40] — governments have a powerful role to play in shaping demand for sustainable products and services. Examples of national actions to boost demand for green products through public procurement are provided in Box 6.8.

Box 6.8

Boosting demand for green products through public procurement

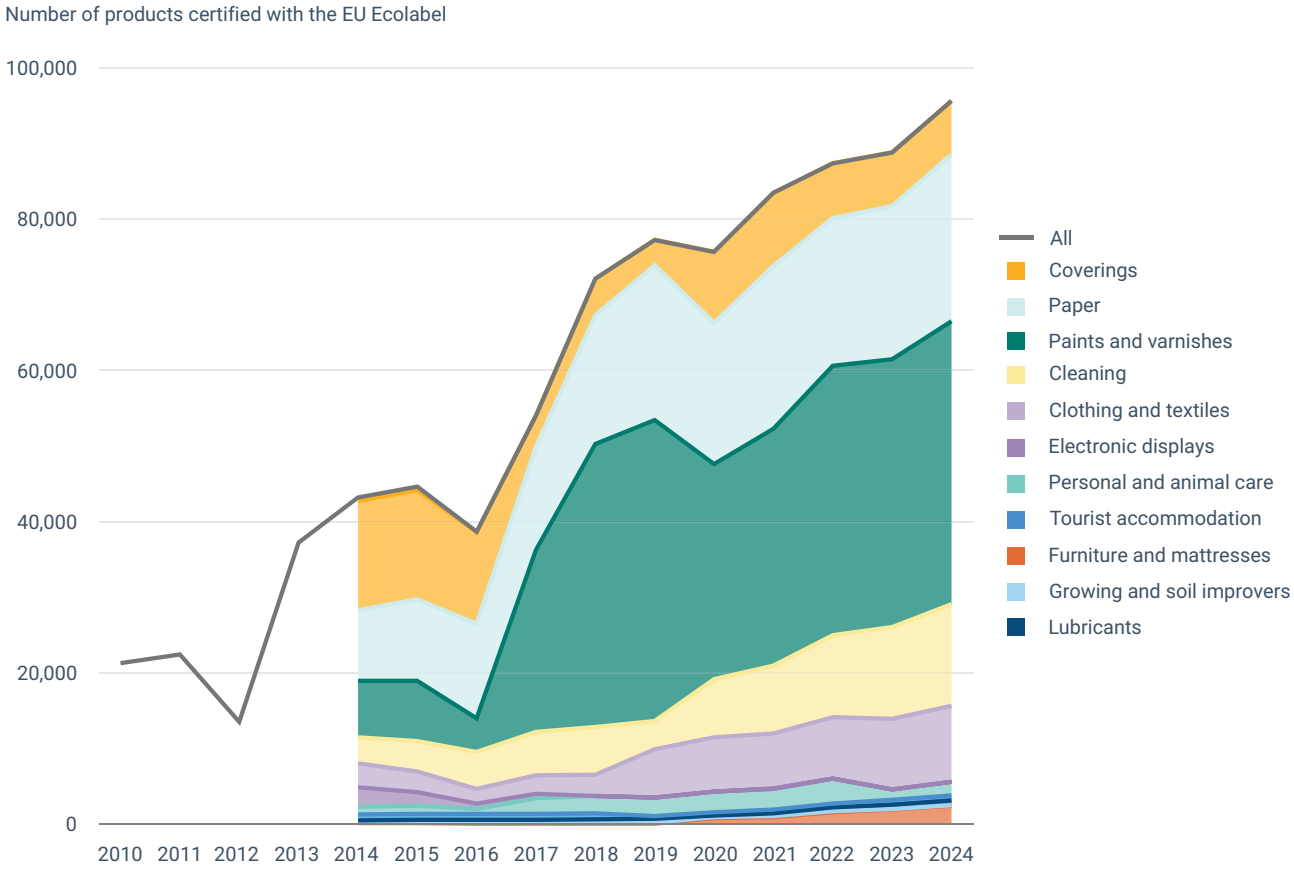
Countries across the EU are using public procurement as a tool to promote sustainable products and services, with a range of examples provided below.

- Belgium's Walloon region has a strategic framework for green public procurement.
- Czechia's national strategy for public procurement integrates green criteria into public purchasing.
- In 2022, Denmark introduced eco-labels and life-cycle costing into its procurement for selected product categories, prioritising total environmental impact and long-term value.
- France set targets for public authorities to procure products made from reused or recycled materials in proportions of 20% to 100% depending on the type of product, driving demand for circular solutions.
- Luxembourg's circular economy strategy integrates eco-design and circularity into public purchasing frameworks.
- Poland's public procurement law requires environmental criteria in tenders, offering a legal basis for green procurement.
- Portugal has a range of initiatives incorporating circular economy principles into various levels of procurement, including the green public procurement ECO 360 awards and the sustainability food school programme.
- In Spain, the national green public procurement plan mandates the use of the EU Ecolabel across all levels of government procurement.
- Sweden supports public authorities through its National Agency for Public Procurement, providing clear criteria to promote reuse, recycling and low-impact materials.

The EU Ecolabel — the official EU label for environmental excellence — captures the environmental performance of goods and services, accounting for the potential environmental impacts from all stages of their lifecycle. Over the past 10 years, the number of products certified with the EU Ecolabel has more than doubled (see Figure 6.3).

However, for some product categories the increase has been slower, such as for clothing and textiles, or there has even been a decrease, as for electronic displays. The 2023 Eurobarometer survey found that a significant majority of respondents across the EU would like to see more EU Ecolabel products and services, showing evidence of consumer demand for sustainable products[41].

Figure 6.3 **Product certifications under the EU Ecolabel from 2010 to 2024**



Source: EEA[41].

This reflects a willingness among Europeans to adopt more sustainable consumption habits. In 2024, 60% said they were ready to pay more for products that are recyclable, produced sustainably and easier to repair. Notably, this share declined from 72% in 2007 to 59% in 2024, potentially due to higher inflation rates reducing households' financial capacity to afford sustainable products[42]. In a context where affordability influences consumer choices, prices need to enable all European households to choose to go green in their daily lives[43].

Closely linked to consumer demand for sustainable goods and services is the need to ensure transparency, accountability and reliability when businesses report on their

own progress. The EU has put in place legislation to oblige companies to report and to ensure the transparency, credibility and accountability of their claims. This has the potential to prevent greenwashing and act as a powerful driver of change.

From 2025, the corporate sustainability reporting directive will require all large and listed companies to report on sustainability. The Omnibus I and II proposal aims to reduce the scope of the directive by about 80%, focusing on the larger entities and limiting the information that companies or banks can request from their smaller suppliers. Similarly, the scope of the directive on corporate sustainability due diligence is reduced, lifting the obligation from companies to systematically conduct in-depth assessment of adverse impacts on the environment.

Digitalisation offers businesses opportunities to cope with disclosure requirements. Digital technologies can enable improved monitoring and modelling of a company's impacts, as input to reporting(44). The proposed green claims directive will, if adopted, require companies to substantiate environmental claims through assessments based on credible evidence set against international standards.

In terms of investment in sustainable businesses, in the EU around 20% of companies' capital investments are aligned with the EU taxonomy. The highest investments are made in the utilities sector, in particular by electricity providers where over 60% of investments are taxonomy-aligned. Capital expenditure aligned with the EU taxonomy reached EUR 250 billion in 2023(45).

Comprehensive statistics on the prevalence of sustainable business models across Europe and their positive impact are not available. Despite the progress, sustainable business models remain niche, while unsustainable business models continue to dominate across all systems. Given the strong incentives for generating financial profits, it is unlikely that businesses can take adequate responsibility for protecting the environment and climate, reinforcing the urgent need for a vision-driven policy framework in which sustainable businesses can thrive(46).

6.2.2 Harnessing technological innovation

Technological innovation is key to changing the dynamic between the EU's economy and nature. The innovation process encompasses the invention, emergence, diffusion and stabilisation of new technologies or practices(47). Innovation is not solely driven by supply-side factors but also shaped by demand-side conditions, including the active diffusion, implementation and use of innovations.

Closing the innovation gap with the US and China, especially in the area of advanced technologies, is one of Europe's priorities(48). At the heart of Europe's sustainability agenda lies the twin transition, whereby green and digital transformations must advance hand-in-hand. Each must reinforce and amplify the other to drive a more resilient, competitive and sustainable Europe (see Box 6.9).

Box 6.9

Towards a green and digital Europe

The digital transition is advancing at pace, driven by breakthroughs in Artificial Intelligence (AI), unprecedented volumes of and access to data, and advances in technological capabilities. Its rapid evolution is transforming economies, societies and institutions, making digitalisation a driving force for structural change. In parallel, the green transition is gaining momentum across key societal systems, including the energy, mobility and food sectors and the built environment, as Europe confronts the triple planetary crisis of climate change, biodiversity loss and pollution.

Digital technologies are becoming increasingly indispensable for achieving environmental objectives. In the energy sector, for example, digital systems can improve demand-side flexibility, enable smart grids and optimise resource use, all of which are critical to building low-carbon and resilient energy infrastructures. More broadly, technologies such as AI and the Internet of Things facilitate data-driven decision-making, real-time monitoring, predictive maintenance and the optimisation of complex systems across a wide range of sectors.

However, digitalisation also brings significant environmental risks. Digital technologies are resource-intensive, energy-demanding and generate increasing volumes of electronic waste. Without targeted policy intervention, the digital transition risks undermining climate objectives. The International Energy Agency (IEA), for example, projects that electricity demand from data centres alone could double by 2030 — a stark reminder that digital growth must be aligned with energy and climate policy.

To ensure digitalisation reinforces, rather than undermines, Europe's sustainability ambitions, it is essential to address its environmental impacts through proactive policy and regulation. Measures must include powering information and communication technology (ICT) infrastructure with renewable energy, implementing energy-efficient cooling solutions and promoting low-energy hardware and software design. It is equally critical to enhance the circularity of digital products by prioritising repairability, reuse and recycling throughout their lifecycle.

Measuring and disclosing the environmental impacts of digital technologies must become standard across the EU policy landscape. Policy instruments such as the scheme for rating sustainability of data centres, ecodesign for sustainable products regulation and the introduction of Digital Product Passports are crucial steps in this direction. These instruments improve transparency, facilitate sustainable product design and enable circular value chains, helping to align the digital economy with resource efficiency and climate neutrality goals.

Incremental changes to technology tend to be implemented within the relevant industrial sector, such as the application of end-of-pipe techniques to a production process; these changes can generally be implemented quite quickly. More profound technological advancement results from making new technologies financially and socially attractive to achieve market penetration, as seen for solar photovoltaics and wind turbines[47]. As an example, the rapid expansion of renewable energy in recent years, which created jobs and accelerated reductions in GHG emissions, was enabled by dedicated policies and rapid technological progress[49], made more urgent by the energy crisis[50].

The eco-innovation index and European innovation scoreboard show steady improvements in overall innovation performance at the European level, even though green innovation trends related to patents and exports have been in decline[51]. The EC's eco-innovation index measures performance against five themes, namely: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes. It shows a steady growth

in both eco-innovation inputs and outputs from 2017 to 2021, largely driven by enhanced resource efficiency[52] (see briefing 'transformative innovation').

Looking specifically at technologies to support water resilience, Europe is a global leader and accounts for 40% of all related patents globally[53]. As such, efforts to promote sustainable water management under the Water Resilience Strategy present a business opportunity for companies bringing water technologies to market.

Despite this progress, the Draghi report found that while Europe is a leader in cleantech, weaknesses in the innovation ecosystem and a fragmented single market present obstacles to commercialisation, with research and innovation (R&I) spending concentrated in mature industrial sectors such as the automotive industry[48].

In terms of barriers to commercialisation, a survey by the European Investment Bank found that firms' capacities to commercialise innovation in the EU is constrained by a financing gap, with access to finance representing a severe challenge for smaller companies. In terms of how to foster commercialisation, 43% and 55% of medium and large companies respectively cite consistent regulation in the context of the EU single market as the main lever[54]. These constraints on commercialisation are not new and fostering innovation has long been an EU priority.

In 2022, EU gross domestic expenditure on research reached EUR 355 billion, representing 2.24% of GDP; this share had only slightly increased from 2.08% in 2012. The EU goal is to raise research and development investment to 3% of GDP by 2030, with only five out of 27 Member States currently spending above 3% on research and development (R&D; see briefing 'transformative innovation'). At the EU level, Horizon Europe is operating with a budget of EUR 93.5 billion for the 2021-2027 period. Central elements include the Missions under the Horizon Europe Programme and the European Innovation Council's Pathfinder instrument.

Meanwhile, the New European Innovation Agenda identifies clean technologies as key to both the green transition and strengthening Europe's global competitiveness. The European Innovation Council has a budget of €10.1 billion to support innovations of a breakthrough and disruptive nature, and those with scale-up potential that are too risky for private investors, with a focus on funding startups and small and medium-sized enterprises (SMEs).

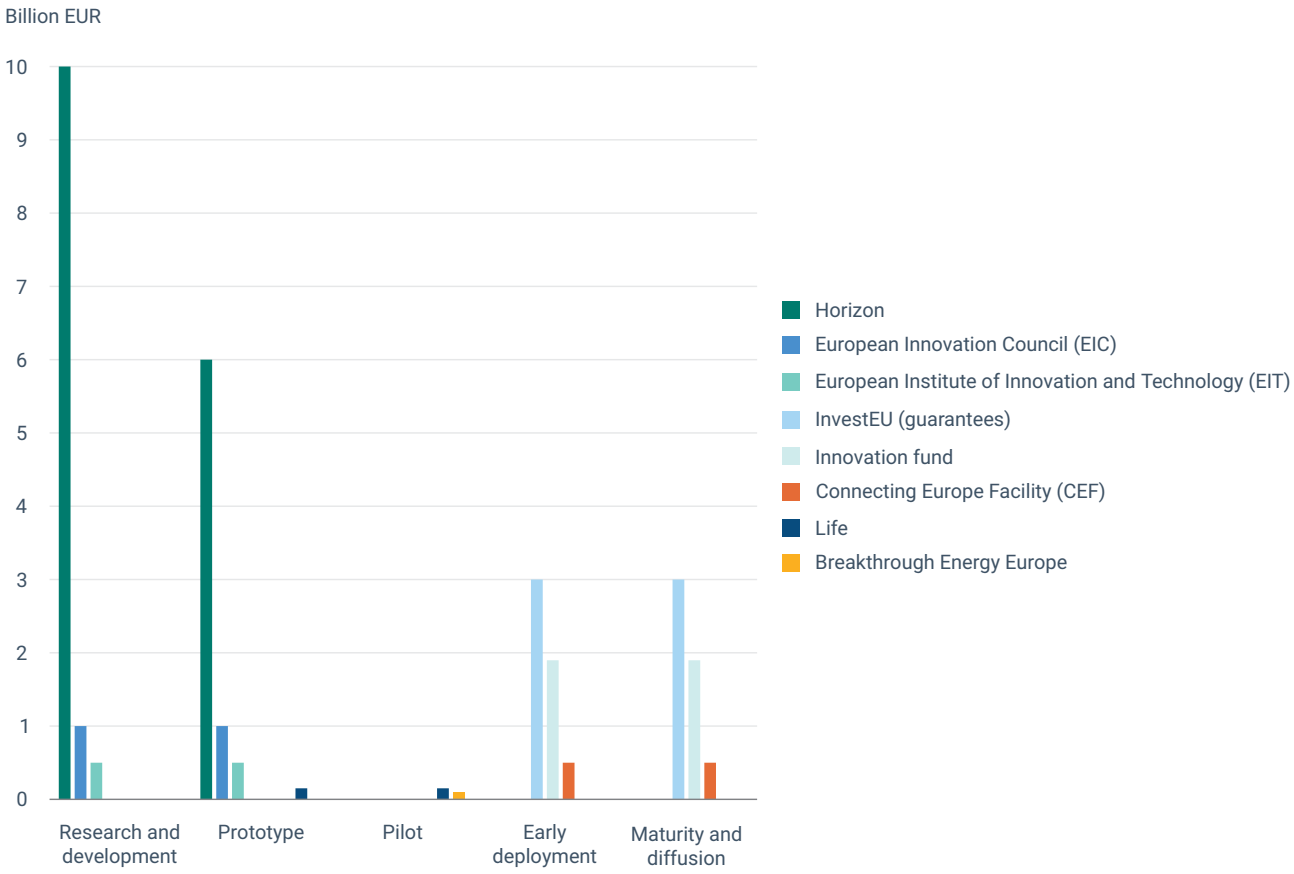
The EU Innovation Fund aims to bring to the market net-zero and innovative technologies to decarbonise European industry while also fostering competitiveness. The revenue is derived from the EU ETS scheme. The total funding depends on the carbon price and is expected to amount to EUR 40 billion from 2020 to 2030. The Innovation Fund focuses on highly innovative projects in the following areas:

- low-carbon technologies, processes and products in energy-intensive industries;
- CCU;
- the construction and operation of CCS facilities;
- renewable energy generation; and
- energy storage.

However, the funding gap persists for the pilot phase of innovation in the EU, exacerbated by low access to venture capital in Europe. Figure 6.4 illustrates the availability of public funding for climate-related technologies in the innovation phases. Additional support for the pilot and demonstration phases is needed in the

form of further grants, loans, loan guarantees and government procurement. Closer collaboration between private and public actors, and knowledge sharing on promising new technologies can draw in more private investments. The EC's European Innovation Centre for Industrial Transformation and Emissions gathers worldwide information on innovative industrial environmental processes and assesses their maturity and environmental performance.

Figure 6.4 **Public funding available for climate-related technologies according to innovation phase**



Notes: Annualised estimates are for the period 2021-2027, except for the Innovation fund which is annualised for the period 2020-2030 and Breakthrough Energy Europe which spans the 2018-2023 period; amounts are given in 2022 EUR values.

Source: ESABCC[55].

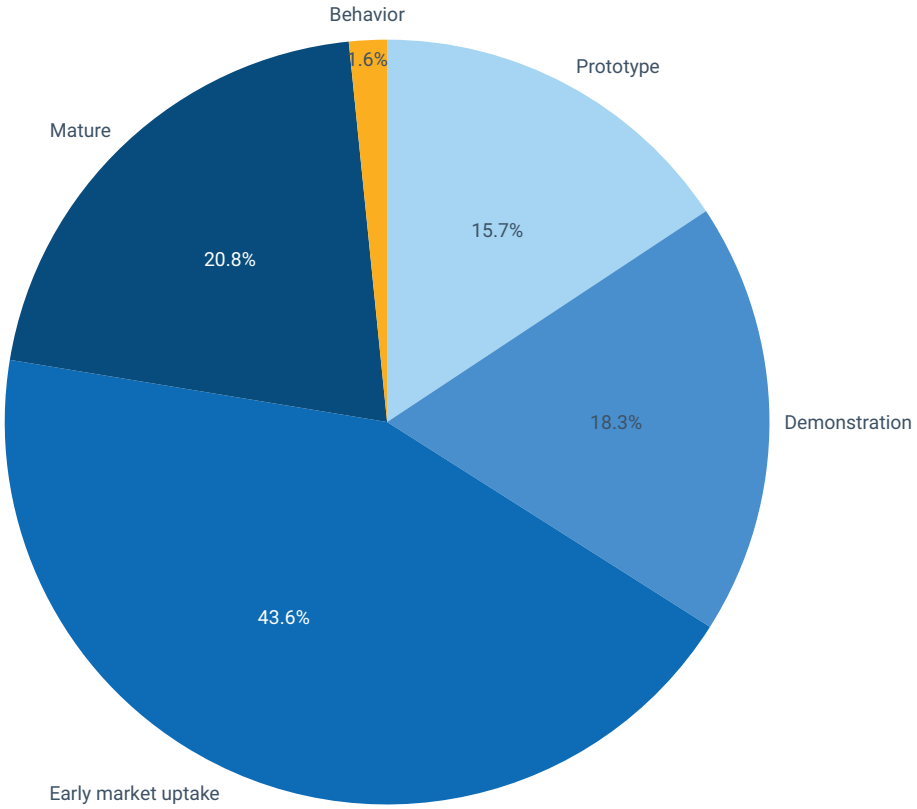
Taking the energy system as an example, achieving net-zero emissions requires a significant acceleration in the speed and scale at which new technologies are deployed, through a combination of investments and policy interventions to generate demand[55]. The IEA Net Zero Emissions by 2050 Scenario shows a pathway for the global energy sector to achieve net-zero CO_2 emissions by 2050 through the application of a range of technologies, with the aim of limiting global warming to 1.5 °C by the end of the century.

In terms of where those technologies are in the stages from prototype through to mature (their technological readiness levels), in 2022 approximately 34% of the cumulative GHG emissions reductions needed by 2050 depend on technologies that are currently at the demonstration or prototype stage and require further

R&D, technical advancements and commercial-scale demonstration pilots to reach deployment at (see Figure 6.5). An additional 43.6% of reductions rely on technologies that are in the early market uptake phase but are not yet commercially mature[56]. To deliver the emissions reductions needed under the IEA scenario, the pace of innovation and the scale up and deployment of technologies must accelerate well beyond the current trajectory.

To achieve this, innovation policy should support the coordinated sharing of knowledge and experiences from first movers to slower adopters, contributing to lower R&D and deployment costs for energy technologies. It should also foster cross-sector synergies and promote positive spillovers across technology areas that share a common knowledge base, thereby enabling broader experimentation and a wider range of application condition. Examples of where this could be helpful include batteries, electrolysers and fuel cells which are all underpinned by electrochemistry. In addition, policies should target the rapid deployment of less capital-intensive, small and modular technologies with lower investment risks, such as solar panels.

Figure 6.5 **Percentage of cumulative global energy emission reductions by 2050 dependent on technologies at different levels of readiness**



Note: Percentages reflect the share of 2050 cumulative emission reductions that depend on technologies at different stages of innovation (technological readiness levels), in order to limit global warming to 1.5 °C by the end of the century, as modelled under the IEA Net Zero Emissions by 2050 Scenario.

Source: IEA[57].

In terms of the potential to harness technological innovation for decarbonisation at the EU level, there are opportunities to commercialise emerging technologies as well as to increase the market penetration of mature technologies. The Net-Zero Industry Act aims to increase the EU's manufacturing capacity in strategic technologies to reach at least 40% of domestic needs by 2030. To achieve this, the EU's strategic autonomy needs to be strengthened by focusing on the full value chain and supply chain for critical raw materials.

For example, batteries are a key technology enabling energy storage in the energy supply sector and decarbonisation of the transport sector through the electrification of cars and vans. However, access to raw materials remains a major strategic challenge and the battery industry in the EU lags behind the global competition, with China dominating the production of low-cost lithium-ion batteries used to power electric vehicles[58].

The EC's 2018 Strategic Action Plan on Batteries addresses the value chain, promotes a cross-border and integrated approach — covering all stages of the battery ecosystem — and aims to boost innovation and competitiveness in the industry[59]. However, to continue electrifying all sectors, Europe needs innovation and deployment across a range of battery technologies, since no single battery chemistry can meet all end-user demands.

The new Battery Regulation has triggered new R&D challenges, such as sustainable sourcing of raw materials, improving recycling rates, and reducing the environmental impact of batteries throughout their lifecycle. The EU's two Important Projects of Common European Interest (IPCEIs) on batteries support these goals with financing and are described in Box 6.10.

Box 6.10

Important Projects of Common European Interest (IPCEI) on batteries

The first IPCEI on batteries, launched in 2019, includes 17 companies from seven Member States (Belgium, Finland, France, Germany, Italy, Poland and Sweden). The project aims to deliver beyond state-of-the-art innovation across the battery value chain, from mining and processing the raw materials, producing advanced chemical materials, designing battery cells and modules and integrating them into smart systems, to the recycling and repurposing of used batteries.

Innovation aims to improve all segments of the battery value chain, reduce the CO_2 footprint and waste generation and develop environmentally-friendly and sustainable dismantling, recycling and refining in line with circular economy principles. The seven Member States will provide up to EUR 3.2 billion in funding in the coming years and this is expected to unlock an additional EUR 5 billion in private investments.

The second IPCEI European Battery Innovation (EuBatIn) was launched in 2021. It includes 42 companies from 12 Member States (Austria, Belgium, Croatia, Finland, France, Germany, Greece, Italy, Poland, Slovakia, Spain and Sweden). The IPCEI EuBatIn will cover the entire battery value chain from the extraction of raw materials, design and manufacture of battery cells and packs to recycling and disposal in a circular economy, with a strong focus on sustainability. It is expected to contribute to the development of a whole set of new technological breakthroughs, including different cell chemistries and novel production processes as well as other innovations in the battery value chain. This is in addition to what will be achieved thanks to the first battery IPCEI. The 12 Member States will provide up to EUR 2.9 billion in funding in the coming years, which is expected to unlock an additional EUR 8.8 billion in private investments[60].

Carbon capture, utilisation and storage (CCUS) involves the capture of CO_2, which is then either compressed and transported to be injected deep underground (CCS) or used in a range of different applications (CCU). CCUS has the potential to:

- tackle emissions in hard-to-abate sectors, such as cement, iron and steel or chemicals;
- produce fuels, including hydrogen; and
- remove CO_2 from the atmosphere[61].

It is important to note that the climate benefits associated with CCUS depend on the CO_2 source, the carbon intensity of energy use in the conversion process and the time for which CO_2 is retained in the product. However, these applications are not yet mature and their market application remains very limited; currently only a handful of large-scale plants capture CO_2 for use in synthetic fuel and chemicals production globally.

The Net-Zero Industry Act aims to enhance the availability of CO_2 storage sites, with a binding target for EU carbon storage such that annual injection capacity should reach at least 50 Mt of CO_2 by 2030. The Act sets obligations for several oil and gas producers to help achieve this target. However, the Scientific Advisory Board on Climate Change warned against overestimating the mitigation potential of CCS in the EU's long-term planning, in a context where market penetration remains very limited in Europe[75].

In the EU, construction of the FlagshipOne e-methanol plant began in Sweden in 2024, which aims to capture CO_2 from a biomass-fired combined heat and power plant to produce methanol for e-methanol shipping vessels in 2025. Two additional e-methanol plants sourcing CO_2 from waste-to-energy plants are in the pipeline[62].

Fossil fuel phase-out in the EU should be the priority when decarbonising the EU's energy systems, with CCU and CCS deployed to capture CO_2 from fossil fuel uses that cannot currently be replaced by renewables[55]. In its communication on sustainable carbon cycles, the EC states it aims to capture between 300 megatonnes (Mt) and 500 Mt of CO_2 from waste, biomass and the atmosphere to meet the EU's net zero 2050 target. EU efforts to promote CCUS deployment include funding under the Innovation Fund and Horizon Europe, as well as EGD support to demonstration projects in fuel and chemical production.

EU policies incentivising demand for CCU-based fuels include specific fuel mandates under the ReFuelEU aviation regulation, the GHG intensity objective under FuelEU maritime regulation and the general objective to reduce the GHG intensity of transport fuels under the renewable energy directive.

In 2023, Europe's hydrogen production capacity was approximately 11.23 Mt, while hydrogen output was approximately 7.94 Mt with less than 1% of this production from clean technologies (i.e. involving carbon capture or hydrogen produced from water electrolysis)[63]. Renewable hydrogen — produced by using renewable electricity to split water into hydrogen and oxygen — plays a central role in the EC's energy strategy, with REPowerEU aiming to see renewable hydrogen production rise from nearly zero in 2022 to 20.6 Mt (half domestic and half imported) by 2030[64].

However, infrastructure to support the hydrogen market needs to be set up in parallel. The Clean Hydrogen Partnership is:

- advancing innovation along the value chain for hydrogen technologies;

- funding projects on electrolysis technologies, large-scale demonstration of hydrogen storage, liquid hydrogen refuelling stations, fuel cells (for maritime applications and non-road mobile machinery) and next generation hydrogen turbines; and
- retrofitting machinery in hard-to-abate industries(1).

The EC has approved four IPCEIs on hydrogen since 2022, aiming to scale up hydrogen production, improve technological maturity, and establish a functional EU-wide hydrogen market (see Box 6.11).

Box 6.11

IPCEIs on hydrogen

The EC has approved four Important Projects of Common European Interest (IPCEIs) on hydrogen since 2022. The aim is to scale up hydrogen production, improve technological maturity and establish a functional, EU-wide hydrogen market.

- Hy2Tech supports innovation across the hydrogen value chain, from production to storage, distribution and application in the mobility sector.
- Hy2Use targets industrial applications and infrastructure, supporting the deployment of electrolysers and pipelines, and the integration of hydrogen in hard-to-abate sectors like steel and cement.
- Hy2Infra focuses on infrastructure, including large-scale electrolysers, hydrogen transmission and distribution pipelines, storage facilities and handling terminals for liquid organic hydrogen carriers.
- Hy2Move focuses on hydrogen-based mobility, including the development of high-performance fuel cells, on-board storage and on-site hydrogen production for refuelling stations.

The European Scientific Advisory Board on Climate Change points to techno-economic limitations in the role of hydrogen in integrated and decarbonised energy systems, calling for hydrogen deployment to be targeted at uses that cannot be electrified directly, notably in industrial processes and fuels for aviation and shipping. Blending fossil gas with hydrogen and using fossil gas in the production of hydrogen should be avoided, considering the risks of carbon lock-ins and methane leakages as well as the immaturity of CCS and CCU(55).

6.2.3 Accelerating industrial transformation

A profound transformation of European industry is crucial to realising Europe's ambition to become a more resilient, sustainable, circular and regenerative economy while maintaining and fostering its international competitiveness(65). The Clean Industrial Deal aims to secure the EU as an attractive location for manufacturing, including for energy intensive industries, and to promote cleantech and new circular business models(66). The deal presents measures to boost production — with a focus on energy-intensive industries such as steel, metals and chemicals that urgently need support to decarbonise — and the cleantech sector. The latter is at the heart of future competitiveness and necessary for industrial transformation, circularity and decarbonisation.

Circularity provides a means to reduce waste and extend the life of materials by promoting recycling, reuse and sustainable production. The deal recognises that maximising the EU's limited resources and reducing overdependencies on third-country suppliers for raw materials is crucial for a competitive and resilient market.

The EC's policy brief, *Industry 5.0: A Transformative Vision for Europe*, calls for industry to be 'regenerative and restorative by design and by action, "giving back" the resources used in the past, interdependent with the natural world, adaptive to change and based on core accountability for social justice'[65]. Key principles for delivering this vision include:

- redesigning production to eliminate waste and pollution;
- keeping products and materials in productive use; and
- regenerating natural systems and enhancing carbon sinks.

Promising innovations must be upscaled — enabled by subsidies, capital grants, infrastructure investments and regulations. This must be coupled with measures to phase out polluting technologies[47].

Circular economy measures in industry need to move beyond recycling materials and managing waste: they must also reduce the demand for materials and reduce EU dependencies on imports of critical raw materials. The implementation of the ecodesign for sustainable products regulation is crucial in scaling up circular product design and ensuring that products are durable, maintainable, repairable, upgradable and recyclable. Other recent policy revisions are also shifting the focus from the end-of-life phase for products to the whole lifecycle (e.g. the batteries regulation and the proposed end-of-life vehicles regulation).

The EC recommendation for products that are safe and sustainable by design provides a voluntary approach to guide the innovation process for chemicals and materials, aiming to minimise harm along the product lifecycle. Future decisions on policy proposals, such as green claims and carbon removals and carbon farming, will also provide important signals to the market.

There are synergies in the circularity and decarbonisation agendas, with circularity reducing GHG emissions through more efficient material flows. For example, if glass waste is collected and processed into recyclables, and used to produce new glass, then the glass industry needs less energy than when using virgin materials.

The waste sector was responsible for 3.8% of GHG emissions in the EU in 2023[67]. These are generated by the treatment and disposal of solid and liquid waste, with methane from landfills accounting for about 70% of these emissions[68]. Better use of waste as a resource would help reduce emissions in other sectors. Options to reduce emissions from waste treatment are shown in Table 6.1 below.

Table 6.1 Opportunities to reduce emissions from waste treatment

PATHWAYS OF WASTE	OPTIONS TO REDUCE EMISSIONS	OTHER SECTORS IMPACTED
Waste prevention	**Reduce**: measures to reduce waste, including extending product lifetime. This affects all other pathways.	Waste prevention reduces emissions across all sectors.
Processing and recycling Residues from sorting processes are usually either landfilled or incinerated	**Recycling**: optimisation of sorting and processing to reduce impacts.	Emissions due to fuel/energy needed for the recycling process accounted for in the energy sector. Where recycled materials replace the need for virgin materials, the production of virgin materials and related emissions from manufacturing and industry will be reduced (industrial processes and product use (IPPU)/energy).
Biological treatment Composting and anaerobic digestion contribute methane and nitrous oxide emissions. Mechanical-biological treatment has to be reported under its component processes e.g. sorting and biological processes	**Recovery/recycling:** use biological processes to recover energy from waste. **Optimise:** processing. **Reduce:** methane and nitrous oxide leakage.	Clean compost/digestate can substitute mineral fertilisers/soil improvers (IPPU/agriculture). However, the output of mechanical- biological treatment is too contaminated to be used as fertiliser or soil conditioner on land. Methane from anaerobic digestion can be used as fuel for energy production, replacing alternative fuels.
Incineration CO_2 emissions during treatment: • Without energy recovery • With energy recovery (emissions not reported under waste sector)	**Recycling**: optimise separate collection or extraction of recyclables before incineration. **Recycling**: extract some recyclables from the incineration slag. **Recovery**: optimisise energy recovery process. **Reduce**: prevent waste, particularly from fossil-based materials.	Energy recovery through incineration leads to new/replacement activity data for energy generation. Incineration slags can in some cases be treated and replace some virgin (mineral) materials (IPPU/energy). Metals extracted from slags can replace some virgin metals — metals sector (IPPU/energy). Preventing fossil-based products from being produced can reduce upstream emissions in manufacturing (e.g. plastics).
Landfill Generation of methane during degradation of biodegradable waste	**Recycling**: improve collection, sorting and processing. **Recovery**: capture methane. **Disposal**: divert waste from landfill to other pathways, pre-treat to reduce biological activity, close and remediate landfills. **Reduce**: prevent biodegradable waste.	Increased recycling may have an impact on waste transfer routes (transport), energy consumption and replacement of virgin materials (IPPU/energy). Methane captured from landfills can be used for energy recovery. Downstream impacts of diversion to other pathways. Prevention can reduce upstream impacts in manufacturing/agriculture due to decreased production emissions.
Waste transport	**Optimise:** waste transport and collection systems.	Measures related to waste treatment pathways may have a knock-on impact on transport of waste, goods and materials. Transport emissions are accounted for in the transport sector.

Source: EEA[68].

Going forward, there is an opportunity to include circular economy actions more comprehensively in national climate policies and measures to reap synergies and accelerate reductions in GHG emissions[68].

The challenge in the context of the energy transition is to increase the use of renewable energy for heating and cooling, to electrify industrial processes and to scale up decarbonisation technologies, such as renewable hydrogen. As mentioned in Chapter 1, the energy crisis triggered by Russia's invasion of Ukraine has accelerated the transformation of energy markets[69].

The single market provides a key lever in Europe's response to the energy crisis, enabling a coordinated emergency response with interventions in both the electricity and gas markets as well as the acceleration of permitting for renewables[70]. In 2023, the share of renewable energy in final energy consumption stood at 24.5% in the EU[71]. Rising energy prices coupled with incentives aimed at mitigating the burden for consumers stimulated a rapid uptake in solar photovoltaics across six key markets, namely Germany, Spain, the Netherlands, France, Italy and Sweden[69]. Looking forward, the Letta report calls for 'a decisive step towards market integration and common action' to deliver a secure, affordable and sustainable energy system[83].

Industrial electrification requires additional renewable energy infrastructure, expanded transmission and distribution grids, energy storage and smart grids. Energy-intensive industries, such as cement, aluminium and steel, face challenges due to their 'hard-to-abate' characteristics. Investment is needed to accelerate the deployment of clean technologies, such as reducing the clinker-to-cement ratio in cement production, industrial waste heat recovery, and 'green steel'.

Regarding the production of green steel, a plant is under construction in Boden, Sweden, which aims to use renewable hydrogen to produce 5 million tonnes of green steel annually by 2030, cutting steelmaking emissions by 95%[72]. Nevertheless, the slow development of pipeline infrastructure for renewable hydrogen is prolonging dependence on old technologies and slowing down the transition[73].

Due to their current dependence on fossil fuels, energy-intensive industries will require support in order to transition to electrification while competing with operators outside the EU that benefit from cheaper energy supplies and weaker regulation. The Carbon Border Adjustment Mechanism (CBAM) will be crucial for protecting competitiveness and ensuring that the EU's climate objectives are not undermined, by ensuring that a price has been paid for the embedded carbon emissions generated in the production of certain goods imported into the EU. The mechanism will apply to cement, iron and steel, aluminium, fertilisers, electricity and hydrogen from January 2026.

State aid can be used to support the phase out of carbon-intensive technologies in heavy industry, as foreseen in the EC's Competitiveness Compass[74]. As EU heavy industry asset stock expires, there are opportunities to shift to cleaner options. Increasing carbon prices create an incentive for companies to avoid investments in fossil-fuel technologies that would create a 20-year carbon lock-in and stranded assets over the long term.

As discussed in the section on harnessing technological innovation above, CCS, CCS and CCUS are seen as solutions for the decarbonisation of hard-to-abate industries. Indeed, key industries, including energy production, heavy manufacturing and waste management, rely on CCS to deliver their GHG emission reductions. The EC's industrial carbon management strategy identifies a set of actions to be taken, at EU and national level, to establish a single market for CO_2 in Europe and to foster investments in industrial carbon management technologies.

Looking at other sectors, buildings account for one-third of EU material consumption and contribute 35% of its annual GHG emissions. Circularity in the construction sector — by extending the lifespan of buildings, designing for reuse, substituting high-carbon materials and promoting recycling — could reduce material-related GHG emissions along a building's lifecycle by up to 61%[76]. Box 6.12 provides an example of the use of bio-based waste to produce construction materials.

Box 6.12

Use of bio-based waste in the construction sector

Using bio-based waste in construction offers a sustainable alternative to traditional materials, promoting lower carbon emissions and resource efficiency while supporting local economies. Recycling waste also mitigates the pressures on ecosystems from using virgin biomass feedstocks. Biowaste like wood fibres and agricultural residues (straw, rice husks, hop and hemp fibres) can be used to create sustainable building materials. As an example, hemp residues are used to produce hempcrete, a bio-composite made from hemp and lime that provides insulation and resists mould.

Currently, bio-based waste material use remains niche due to a lack of infrastructure, low market awareness amongst developers and architects, and the fact that these materials are typically more expensive than virgin ones. Several Member States have taken action to address these barriers.

Sweden requires climate declarations for new build, whereby construction projects must document their climate impacts. Denmark has tightened the climate requirements for new build to an average of 7.1kg CO_2e/m^2/year. Both policies incentivise the use of low-carbon intensive building materials, such as biowaste.

The Finnish Bioeconomy Strategy promotes the use of wood and other natural materials in new construction, and fosters new technologies to increase energy and material efficiency. The Austrian Bioeconomy Strategy includes measures to enhance the use of wood in construction, including wood residues.

Regarding the electrification of private mobility, the European automobile sector has been relatively slow to respond to the shift from internal combustion engines to the electrified powertrains used in electric vehicles and has lost market share to competitors in China and the US. China now dominates both battery cell and electric vehicle production; it produces 71% of battery cells and 66% of electric vehicles globally[77].

In early 2024, with the aim of bolstering European battery capacity, the European Investment Bank financed Europe's first circular battery production gigafactory, Northvolt Ett, in Skellefteå, Sweden. The EUR 942.6 million deal was financed by EUR 453.6 million from the Swedish National Debt Office Riksgälden, EUR 362.9 million from the InvestEU programme and EUR 126.1 million from commercial banks[78]. In a significant setback, Northvolt filed for bankruptcy in 2024 and closed down cell production in Sweden in 2025, casting doubts on the future of the Northvolt battery plant currently under construction in Germany[79].

More broadly, 12 out of 16 planned European-led battery factories have been delayed or cancelled due to a lack of skilled technicians, high energy costs, slowing demand for electric vehicles and a lack of economies of scale compered to Chinese competitors[80]. The slow shift in the European automobile industry towards battery technology has resulted in weak demand in Europe, with European automakers continuing to lobby to delay plans to phase out combustion engine cars by 2035[81].

Nevertheless, the 2035 zero-emission target sends a clear signal to operators along the electric vehicle supply chain, including battery producers, that EU demand will increase and could be complemented by subsidies for electric vehicles — well-proven to incentivise market uptake across European countries[82].

A key EU ambition is to carve out space in the clean technology market, seizing the opportunity presented by the global drive for decarbonisation and challenging Chinese dominance in clean technology and electric vehicles.

Europe faces a trade-off between the speed of decarbonisation in Europe and the sustainability and competitiveness of its domestic industries. While Chinese technology currently offers the cheapest and most efficient route to decarbonisation, investing in the European industrial transformation offers a source of sustainable economic growth and employment(48).

6.2.4 Fostering social innovation

Social innovation entails changes to social norms, behaviours and institutions. It goes beyond incremental changes in technology and has the potential to foster deep transformations in European society. Fostering new social relations, organisational models and behaviours provides the necessary complement to technological advancements.

Changes in social practices and lifestyles can shift consumption to less material- and carbon-intensive products and services, and reduce environmental pressures from consumption, especially if facilitated by product policy, circular business models and well-informed consumer choices(84).

A 2024 Eurobarometer survey on European attitudes towards the environment found a readiness for more sustainable consumer behaviour, with almost 6 in 10 respondents willing to pay more for sustainable products that are easier to repair, recycle and/or produce in an environmentally sustainable way. People supported reducing the amount of waste by sorting their waste for recycling correctly and using reusable packaging(85). Initiatives are ongoing at the local level, with Box 6.13 summarising efforts to reduce the carbon footprint of food and housing in Brussels.

Box 6.13

Reducing Brussel's carbon footprint through food and housing

Brussels is actively pursuing a just transition to climate neutrality by 2050, underpinning mitigation and adaptation objectives with social fairness. The city's Climate Plan was developed through active engagement with residents, as well as public and private stakeholders. It is cutting the city's GHG emissions while tackling social inequalities to ensure that climate action benefits all residents equitably. The plan sets measurable goals across the energy, housing and food sectors. It targets social inequalities related to exposure to heat and floods, energy costs, and access to healthy food and green spaces.

The part of the plan focusing on food and urban agriculture aims to ensure that urban residents, including marginalised groups, can access affordable, sustainable food while supporting people active in urban agriculture. Concrete measures include the creating food aid distribution channels to ensure access to ecological and healthy food for those in need, and the establishing neighbourhood kitchens in collaboration with local supermarkets in municipalities across the Brussels-Capital Region(4).

Under the energy aspect of the Climate Plan, Brussels is renovating over 1,000 social housing units to improve energy efficiency, ventilation and indoor comfort. The intention is to directly address fuel poverty and heat stress among vulnerable populations, ensuring tangible social benefits from climate action. Thanks to this large-scale renovation, Brussels is mitigating emissions from housing, improving living conditions for disadvantaged residents, and reducing energy costs. In addition, the Plan is boosting the local production and consumption of renewable energy, aiming to double the city's photovoltaic energy production by 2030.

See also Belgium's country profile.

In the food system, initiatives to address food waste include redistribution of surplus food, awareness raising, date-labelling initiatives, as well as fiscal and financial incentives designed to engage all the actors across the supply chain(86). In some countries, environmental sustainability is being incorporated into dietary recommendations. For example, Nordic nutrition recommendations were updated for sustainability in 2023(87).

Community-supported agriculture — where consumers purchase a share of a farm's produce in advance and receive regular distributions of fresh, seasonal food — foster direct relationships between producers and consumers, reducing reliance on industrialised food systems and fostering healthy diets(88). However, high upfront costs for consumers limit accessibility, particularly for low-income households, while other hurdles include limited convenience compared to supermarkets and time constraints related to preparing fresh produce. Stronger policy support, expanded awareness campaigns and enhanced cooperation projects are needed to increase the scale, accessibility and overall impact(89).

With the concentration of the population in urban areas, cities have a key role to play in addressing energy demand. Decentralised collective prosumers — or energy communities — have a role to play in shifting from a conventional top-down power system to a distributed system combining large and small energy producers at different levels of the electricity grid. Energy communities involve cooperation around decentralised and small-scale energy production. They are open and voluntary in nature and involve a business model where people jointly own and participate in renewable energy or energy efficiency projects.

On the Danish island of Samsø, the local community has been a pioneer of the island clean energy transition for more than 20 years and it is a net energy producer (see Box 6.14).

Box 6.14

Denmark's renewable energy island – the Samsø success story

Samsø, an island off Denmark's Jutland Peninsula, provides a leading example of community-driven transformation of local energy systems. In 1997, the island's community committed to shifting away from imported oil, diesel and petrol to become Denmark's 'renewable energy island'. By 2007, it produced more renewable energy than it consumed through wind turbines, biomass-fuelled district heating, solar power and efficiency measures.

Samsø's model relies on social innovation and local ownership. Citizens, farmers, municipal authorities and private investors have collectively invested up to EUR 60 million in renewable infrastructure. Community-owned wind cooperatives and municipally-supported district heating systems channel returns into the local economy.

The Samsø Energy Academy was established in 2007 as a hub for capacity-building, community development and sustainable solutions. The Academy organises workshops and study tours, promoting the island's approach to community engagement and change management through its pioneer guide. Looking ahead, Samsø aims to become completely fossil-free by 2030, expanding renewable energy use into heating, transport and ferry operations via electrification measures[90].

REScoop is the European federation of energy communities, a growing network of 2,500 energy communities from across Europe involving 2 million people who are active in the energy transition. These communities play an increasingly substantial role in the transition to low-carbon systems, devolving energy production and consumption to the local level and empowering citizens[91]. Small-scale prosumers consume energy that they produce, with electric vehicles and heat pumps integrating electricity from decentralised wind and solar installations; this offers the flexibility to accommodate variable supply[92]. Where industrial facilities are sited near urban areas, district heating networks can channel waste heat to residential homes[93].

Currently, people who want to initiate and implement a prosumer project are likely to face several challenges. The cost of the project may be too high, national regulations may not permit a prosumer model that would fit the situation or there may be insufficient volunteers prepared to put in the effort needed to develop the project. Lack of knowledge and expertise can also be an issue, since prosumerism may require expertise in many different areas, including technology, policies, regulations and financing. These barriers can be reduced by effective policies and support frameworks[92].

As an example of the power of consumer choice, the electrification of residential heating through the uptake of heat pumps has significant potential to cut GHG emissions. In their impact assessment setting out pathways towards the 2040 climate target, the EC foresees the installation of close to 60 million heat pumps by 2030 and over 80 million by 2040[94].

According to the European Heat Pump Association (EHPA) the 24 million heat pumps currently installed in Europe substitute 1.6% of EU total annual gas consumption and save 45 mega tonnes of CO_2 emissions annually, which represents around 4.9% of EU emissions from buildings[95]. However, the uptake of heat pump varies significantly across Europe, with overall sales falling in 2023 and 2024 after 10 years of growth. This will need to accelerate to deliver the cuts to building's energy consumption needed to meet the EU's climate targets[96].

Policies and fiscal measures have been successfully used to cut the cost of heat pumps for consumers. Currently five Members States foster uptake through a lower value-added-tax rate on heat pumps than on fossil fuel boilers: Belgium, France, Ireland, Portugal and Romania[97]. Other Member States use instruments such as grants and tax deductions. The electricity-to-gas price ratio also affects sales, with uptake promoted by low electricity prices against higher gas prices.

The recent Clean Industrial Deal aims to ensure equal access to the clean transition for all citizens, and recommends social leasing of expensive clean tech such as zero-emission vehicles and heat pumps. The EC will publish guidance on social leasing in 2025.

Regarding social innovation in the urban context, the New European Bauhaus initiative has a focus on the neighbourhood level to identify sustainable, inclusive solutions tailormade for each community. Engaging citizens and understanding their needs are essential for effective participation to achieve equitable urban outcomes — especially for vulnerable groups. Public engagement in defining a city's visions and pathways can bring buy-in and participation.

The rise of remote and hybrid working has the potential to reduce commuting and its environmental impacts, while reshaping labour markets and urban mobility patterns. The COVID-19 pandemic demonstrated that existing technologies and policies can support effective alternatives to daily commuting. As people increasingly explore flexible arrangements, these shifts could contribute to more sustainable, less car-dependent lifestyles. However, adequate economic and social policies are needed to ensure that changes to working patterns are sustainable[98].

Several EU Missions under Horizon Europe have been looking beyond technological development with a view to supporting sustainability through social innovation[99]. The approaches include high levels of citizen engagement, cross-sectoral collaboration, alignment with EU policies, fostering innovative solutions, mobilising resources and creating platforms for long-term systemic change[99]. The Partnerships for Regional Innovation involves 63 regions and seven cities across four Member States and aims to share good practices and connect regional, national and EU initiatives for the green and digital transformations.

6.2.5 Creating green jobs and building up skills

People's prosperity depends on livelihoods with access to high-quality jobs. At the same time, it is crucial for businesses to have access to people with the right skills and training to enable innovation to be upscaled and industrial transformation to be accelerated. As carbon-intensive activities — such as coal mining and shale extraction — are phased out and operations close, significant job losses are expected in affected regions, typically in rural areas. This could further increase existing social inequalities, and reinforces the need to balance the phase-out of fossil-fuel industries with the build-up of new economic activities[4]. Spain is regarded as a frontrunner in implementing just transition policies, with the country's approach described in Box 6.15.

Box 6.15

Managing the green transition in Spain

Under its Strategic Energy and Climate Framework, Spain aims to decarbonise its economy and phase out nuclear, while at the same time ensuring that the transition benefits society and mitigates negative impacts. Spain is implementing the phased closure of its coal industry, leading to socio-economic impacts, particularly in rural regions already facing depopulation and economic decline. Most coal mines were closed in 2018, with coal-fired power plants now shutting down towards the goal of total closure around 2026-2027.

To manage this transformation, the Spanish Just Transition Strategy ensures equal opportunities for vulnerable groups and rural areas, builds new skills and capacities among workers, and promotes new opportunities. The Strategy prioritises job creation and economic diversification, and delivers capacity building for electricity infrastructure alongside tailored financial support for new businesses. Measures target displaced coal and nuclear sector workers, as well as local businesses and communities dependent on these industries. Special attention is given to groups at risk of exclusion, including women, youth, people with disabilities and the long-term unemployed.

In delivering a just transition, Spain has effectively used European funds, integrating just transition components into its Recovery, Transformation and Resilience Plan, supported by EUR 300 million in NextGeneration EU funds(4). See also Spain's country profile.

The Clean Industrial Deal presents several important flagship actions related to skills and quality jobs for social fairness. These include the Union of Skills — launched in March 2025 to equip people for a competitive Europe — and a Quality Jobs Roadmap. The latter is to be developed together with social partners to support 'fair wages, good working conditions, training and fair job transitions for workers and self-employed people, notably by increasing collective bargaining coverage'(100).

A lack of consensus around defining what green activities, sectors or jobs are, coupled with measurement difficulties, make it challenging to quantify the impact of the green transition on labour markets(101). Nevertheless, data from the environmental goods and services sector indicate that between 2010 and 2021, employment in the sector grew at a faster rate than the EU's overall employment rate(102); in 2022, the number of full-time equivalent employees in this sector reached 6.7 million(103). Employment related to the management of energy resources grew by a factor of 4.3 between 2000 and 2022(103).

In terms of past trends with green job creation, more than 2 million full-time equivalent jobs related to renewable energy and energy efficiency have been created in the EU over the same period. Job creation in these sectors stem from the production of renewable energy and the manufacturing of renewable energy and energy-efficient equipment, as well as installation, engineering and research services. Employment in the production of energy from renewable sources doubled from around 600,000 in 2021 to 1.2 million in 2022(103) (see briefing 'green employment').

Looking ahead, estimates suggest that implementation of the EGD will generate up to 2.5 million additional jobs in the EU(104). Translating this potential into reality will require substantial investment into vocational education and training to ensure that workers' skills correspond to labour market needs(105). The twin — digital and green — transition looks set to drive employment trends up to 2035, requiring a revolution in skills development that involves all workers across all levels of qualification and seniority, sectors and occupations. The supply of skills for jobs in

eco-innovation, as well as technicians to implement green solutions, needs to be fortified through targeted education and training[106].

Meanwhile, workers in declining sectors and regions need to be reskilled to enable them to find new employment. Box 6.16 describes action to reskill workers from the shale energy sector in Estonia.

Box 6.16

Phasing out shale energy while creating green jobs in Estonia

Estonia is managing the transition away from its carbon-intensive oil shale industry in Ida-Virumaa through a comprehensive, socially-inclusive plan that balances environmental goals with economic and social equity. Estonia's Territorial Just Transition Plan aims to diversify the regional economy, support workers, and address health and social disparities while moving Estonia towards renewable energy and energy efficiency improvements.

The plan focuses on economic diversification. The government plans to create over 1,100 jobs in green sectors and retrain around 13,500 workers for low-carbon employment. Investments in SMEs as well as innovation, are prioritised, with 80% of the Plan's budget allocated to economic development. One example is the establishment of a factory producing rare earth magnets, supported by an EU grant.

To support workers during the transition, the Plan includes a fund to provide transitional income support for oil shale workers who are laid off, covering their wage loss as they seek less carbon-intensive employment. Environmental health is another priority. Ida-Virumaa's residents experience poorer health than the rest of Estonia, largely due to pollution from mining and industrial activities. The Plan aims to address these inequalities by improving healthcare and investing in community well-being[4]. See also Estonia's country profile.

Employment projections suggest the potential for job creation varies across European regions and across sectors[107]. The construction industry, for instance, is expected to benefit from significant job creation stemming from energy efficiency enhancements and the expansion of renewable energy infrastructure[108] as well as retrofitting of buildings with property-level flood resilience measures.

The Net-Zero Industry Act goal to expand net-zero industrial capacity is foreseen to create additional jobs to enable the installation of these technologies[109]. Up to 2030, it is estimated that the investment needs for retraining, reskilling and upskilling in the manufacture of strategic net-zero technologies alone will range between EUR 3.1 billion and EUR 4.1 billion[109].

The transition to a more circular economy is also expected to result in significant job creation. 'Circular jobs' are those that either directly involve or indirectly support the transition to a more circular economy[110]. In 2023, 4.4 million people were employed in circular economy sectors in the EU, with a 14% increase recorded since 2010[111]. The circular potential of the European remanufacturing market is expected to expand from its current value of EUR 31 billion to EUR 100 billion by 2030, generating 500,000 new jobs[66]. However, current studies tend to focus primarily on job creation and less on job quality. Ensuring decent work in the circular economy is key for a just transition towards environmentally-sustainable economies and societies[112].

Finally, action to save water under the Water Resilience Strategy is also foreseen to create new jobs. In 2022, the water technology sector provided 1.6 million jobs across 81,500 enterprises, mostly SMEs[113]. A recent estimate found that up-scaling water saving technology across four industrial sectors – namely semi-conductors, data centres, renewable hydrogen and electric vehicle batteries – could support over 9,600 jobs per year[114].

The EU is currently investing in skills through several funding mechanisms. The EU Cohesion Fund is investing EUR 44.2 billion towards skills over the period 2021 to 2027[115]. The vast majority comes from the European Social Fund Plus, followed by the Just Transition Fund and the European Regional Development Fund. The Recovery and Resilience Facility, a temporary instrument of the EU post-pandemic recovery programme NextGenerationEU, also supports skills-related investments[106].

In terms of governance, the involvement of all relevant stakeholders, particularly employer organisations and trade unions, may help to foster the creation of long-lasting feedback loops between vocational education and training and other skill policies[116]. In addition, a sectoral focus on education, training and skills policies is needed to tackle the opportunities and challenges related to the green transition[117]. Box 6.17 describes a public-private collaboration in Austria to develop labour market skills for low-carbon sectors.

Box 6.17

Skills development for green jobs in Austria

Launched as a collaboration between the Austrian Trade Union Federation, the Austrian Federal Economic Chamber, the Public Employment Service and federal ministries together with business partners, Austria's Umweltstiftung (Environmental Foundation) is a public-private collaboration that supports the upskilling and re-entry of unemployed individuals into the workforce through targeted training in climate-related sectors. The initiative equips unemployed individuals, particularly women, older job seekers and the long-term unemployed, with qualifications in growing green industries such as renewable energy, e-mobility, waste and resource management, green building technologies and sustainable agriculture.

The initiative promotes gender equality by encouraging women to pursue careers in technical and environmental fields where they have been underrepresented. It also offers pathways to higher education for those with previous qualifications, contributing to lifelong learning and career development.

From April 2022 to April 2025, the initiative invested EUR 10 million in training 1,000 individuals without job-relevant vocational qualifications through apprenticeships and intensive courses. Training was tailored to the needs of companies actively hiring in climate-relevant sectors, ensuring strong employment outcomes. Participants received financial support to cover moving, housing and travel costs[118]. See also Austria's country profile.

It is crucial to monitor skills demand to anticipate imbalances. In this context, novel data sources, for instance online job advertisements, are increasingly being used to learn about the demand for green skills[119]. Although data on green labour shortages is scarce, existing indicators suggest that there is an increasing shortage of workers in sectors essential to the green transition[107]. Improving the participation of women and other underrepresented groups in the labour force could help address labour

shortages; this is in a context where women remain underrepresented in many sectors that are key to the green transition. Policies should enable people of all genders to benefit from the new opportunities arising from the green transition[120].

Migrants can also significantly contribute to the labour market, provided they have access to upskilling and reskilling programmes[121]. Recognising that SMEs struggle to find employees with green skills in the context of an aging EU population[122], the EC has implemented measures to make it easier for them to recruit talent from around the world and recognise professional qualifications and skills gained in third countries faster[123].

6.3 Economic levers for transformative change

6.3.1 Financing sustainability

The EU's financial system facilitates the flow of capital across the economy, contributing to both economic prosperity and financial stability. However, historically, environmental considerations have not been well-integrated into the financial system. As such, there is an urgent need to reorient financial flows towards sustainable investments and to reduce exposure of companies and financial market actors to physical and transitional risks of climate and environmental degradation.

The EC published its Sustainable Finance Action Plan in 2018, outlining three core objectives:

- reorienting capital flows toward a more sustainable economy;
- integrating sustainability into risk management; and
- fostering transparency and long-term thinking.

Building on this plan, the EC introduced a renewed strategy in 2021 to finance the transition to a sustainable economy. Moreover, the EU has taken promising steps towards reforming the financial system to align with sustainability goals and mobilising private and public investments towards sustainable activities. Central to this progress is the alignment of corporate activities with the EU taxonomy, whereby companies and financial market actors are required by the corporate sustainability reporting directive and the sustainable finance disclosure regulation to report information on the sustainability of their activities. Complementing this, the proposed regulation on environmental, social and governance (ESG) rating transparency aims to harmonise and improve the reliability of ESG data to prevent greenwashing and support informed financing decisions.

This information should enable investors, both public and private, to support more sustainable activities, while at the same time reducing the climate and nature-related risks affecting businesses. However, as mentioned above the EC's Omnibus I and II package proposes to reduce the scope of the corporate sustainability reporting directive in order to reduce the administrative burden on businesses.

In terms of public investment in sustainability at EU level, under the EGD Investment Plan, the EU aims to mobilise at least EUR 1 trillion in sustainable investments over the period 2021-2027 through the EU budget and its associated instruments, particularly InvestEU. To meet this target, 30% of the EU 2021-2027 multiannual financial framework and 37% of NextGenerationEU have been devoted to climate action. EU Cohesion policy also contributes, with at least 30% of the European Regional Development Fund supporting EGD objectives and 37% of the Cohesion Fund supporting the 2050 climate neutrality objective.

Meanwhile, 42% of measures under the temporary EUR 648 billion Recovery and Resilience Facility had been dedicated to supporting the green transition by May 2024[124,125]. The EU aims to allocate 7.5% of its budget to biodiversity in 2024-2025, increasing to 10% by 2026-2027 (see briefing 'biodiversity investment needs'.

Initiatives like the Innovation Fund, NextGenerationEU Green Bonds, the Just Transition Fund and the Social Climate Fund are mobilising significant resources to accelerate green investments, creating an indirect 'pull effect' on private investments, in a context where public investment is often necessary to attract private capital[70].

Green bonds have emerged as financial instruments used to finance activities that support climate and environmental objectives. The EU green bond standard is a voluntary framework designed to enhance the effectiveness, transparency and credibility of the green bond market by aligning green bond issuance with the EU taxonomy. The standard provides issuers with clear criteria for defining, tracking and reporting on the environmental sustainability of financed projects, aiming to channel capital towards the EU's climate and environmental goals while preventing greenwashing.

Demand for sustainable finance instruments is increasing, with green bonds accounting for 6.9% of EU bond issuances in 2024, compared to just 0.1% in 2014. The expectation is that demand will continue to increase in the coming years on the back of policy support through the EU green bond standard[131]. Sustainability-linked bonds also emerged in 2019 as a new financial instrument, incentivising the green transition with contractual sustainability targets. Their uptake has been more limited than uptake of green bonds; it peaked in 2021 at EUR 51.8 billion[125]. These trends suggest a growing investor appetite for sustainability-linked products, and a gradual reorientation of financial flows toward climate-resilient and environmentally friendly projects.

Despite these advances, the EU faces a significant investment gap to meet its sustainability goals. Financing the transition to a climate-neutral, nature-positive and circular economy requires a significant upscaling of investments, from both public and, crucially, private sources. To meet the objectives of the EGD, it is estimated that the EU will need to scale up its investments by around EUR_{2024} 743 billion annually until 2030 or by 4.1% of the EU's 2024 GDP each year until 2030 (see Figure 6.6 and briefing 'financing the transitions towards sustainable activities').

The largest investment gap is seen for climate change mitigation, with EC estimates suggesting annual investment needs in the energy system of EUR_{2024} 581 billion (EUR_{2023} 565) billion to meet the EU's 2030 climate mitigation target[127]. That translates into an investment need for the energy system in the order of 3.3% of EU's GDP per year from 2021 to 2030, compared to 1.7% of GDP in the period 2011 to 2020 (a decade with relatively low investments in the energy system).

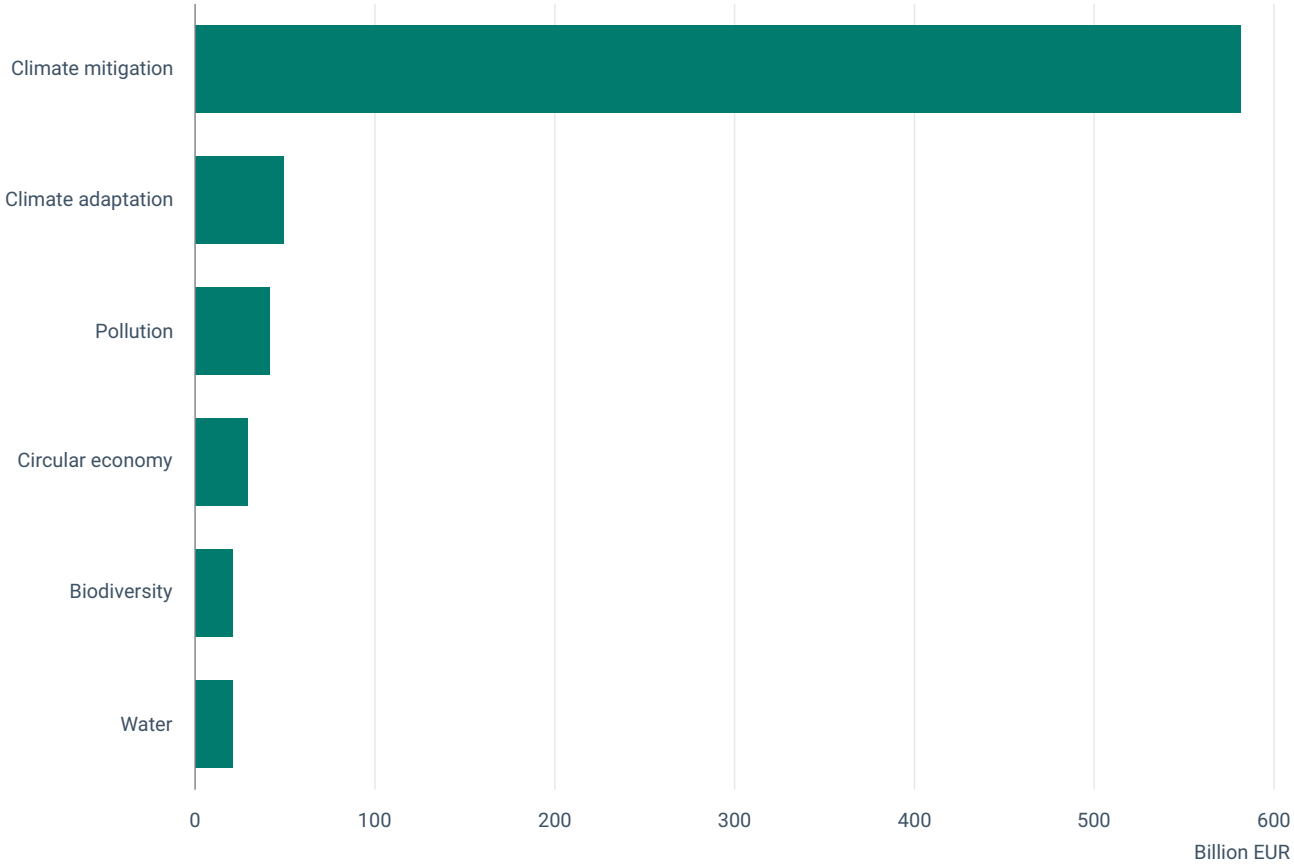
Notably, the increase in investment requirements for 2021 to 2030 also reflects the need to meet the higher energy demand of a growing economy and the fact that investment in the energy system would have to increase regardless of climate mitigation objectives.

Investment gaps across other areas are given below (Figure 6.6):

- For climate adaptation, the estimated investment gap up to 2030 is about EUR_{2024} 49 billion.
- For pollution, the estimated annual investment gap up to 2030 is EUR_{2024} 41 billion.

- For the circular economy, the estimated annual investment gap up to 2030 is EUR_{2024} 29 billion.
- For water, the estimated annual investment gap up to 2030 is EUR_{2024} 21 billion.
- For biodiversity, the estimated annual investment gap up to 2030 is EUR_{2024} 21 billion.

Figure 6.6 **Annual investment gap up to 2030 to meet the EGD's environmental objectives**



Notes: The investment levels and future needs presented are indicative and based on diverse sources and methods, involving significant uncertainties. They are measured at 2024 prices and represent annual averages. It should be noted that the term 'investment', in this context, is more broadly defined than gross fixed capital formation in national accounts and includes elements of final consumption expenditure. The annual investment gap for circular economy refers to 2027 and not 2030.

Sources: EC[2,128,129,130,131]; EU[127]; OECD[132,133] as quoted on the Platform on Sustainable Finance[134].

To address these investment gaps, current investment flows need to be increased and redirected towards sustainable activities. The EU's current investment share is low, at around 22% of GDP, following a multi-decade decline in most large EU countries[48].

While the totals required are high, they are minor when set against the costs of inaction. Between 2021 and 2023, average annual economic losses due to weather- and climate-related extremes reached EUR 44.5 billion[135]. Mitigating and adapting to climate change and addressing the environmental crisis is necessary

to ensure the future security of Europe's population. Indeed, investing now will help reduce future costs, with investments in early adaptation anticipated to deliver social benefits worth double to 10 times their cost[136].

Despite evidence that the costs of inaction vastly exceed today's investment costs, raising finance, particularly for adaptation and nature, remains challenging. At the root of this is the failure of our financial system to accurately monetise climate-regulating and provisioning services; they are neither traded in markets nor directly assigned a monetary value, and thereby do not featured on business balance sheets[137].

Effective valuation of nature is at the heart of mobilising private capital investment in nature and climate. Many sustainable projects are simply not profitable when set against the criteria currently applied by investors. The application of a discount rate to future returns means that equity investors tend to undervalue the longer-term investments. For debt investors, the application of risk premiums and the risk-free rate means that the after-tax rate of return on sustainable projects is often lower than interest rate payments on bonds issued to cover investments[136].

This points to a need for philanthropic and impact investments to de-risk innovations as they scale up and where no obvious monetary return can be realised. The question of profitability and the timescale for returns has become more pertinent with a sharp increase in the cost of capital — crucial for many clean energy investments with high upfront costs — and inflation, which have materially increased project costs and led to many clean energy projects becoming financially unviable.

Investment needs cannot be met by public funding alone, in a context where governments face competing priorities — for healthcare, defence and social infrastructure — amid high inflation and public debt costs. Structural economic challenges, such as an ageing workforce and slower economic growth, further complicate resource allocation[138].

The EU population is expected to peak at 453 million inhabitants in 2026, then decline to around 450 million by 2040. The old-age dependency ratio is foreseen to rise from 33% in 2022 to almost 50% by 2040 in the EU, leading to labour shortages and skills gaps[139]. Adverse macroeconomic consequences include increasing social costs of healthcare and pensions for an ageing population set against an eroding tax base with fewer people in employment[140]. Thus, concerns around fiscal sustainability are set against the need for significant investment in the green transition. The scale of the challenge also varies across countries, for instance, in terms of the investment needs and financing costs[141].

Private capital will need to play a significant role in delivering the investment needed for the green transition, necessitating innovative mechanisms to leverage it at scale. The split between the public and private role in financing additional investment needs is projected to range from a ratio of 1:5[142] up to 1:2[143] and will vary significantly between EU Member States. For example, the European Investment Bank has projected that about 60% of additional investments will be funded from public sources in central and eastern Europe, while the share will only be 37% in western and northern Europe[144].

Levers to redirect private financial flows towards supporting sustainable investments include standards for companies to report comparable and relevant information required by investors and other stakeholders. According to the European Central Bank, the flagship EU regulations aimed at establishing common mandatory European sustainability reporting standards, taken together as a nexus, limit the possibility of greenwashing and enable severe sanctions for sustainability misrepresentations[145].

The European Central Bank concludes that it is important that the EC's push for simplification maintains the elements in the sustainable finance framework that prevent greenwashing. For instance, corporate reporting is critical to tracking whether investments meet sustainability goals, for which better alignment of the different reporting requirements will help enforce transparent and comparable reporting[48]. Policy instruments to ensure that returns on sustainable investments — such as those aligned with the EU taxonomy or the EU green bond standard — are more attractive than unsustainable investments could also help to direct private finance.

Improving the framework for sustainable business — such as through tax incentives or policy instruments to address key barriers like the cost of capital and investment risk — can help address the investment shortfall. In the area of regulatory opportunities, meanwhile, uncertainties regarding which financial activities should be considered sustainable green investments could be resolved through a revision of the EU taxonomy[55]. Future increases in carbon prices under the ETS are expected to increasingly turn industry's attention towards secondary raw materials and material efficiency[146].

There are implementation challenges to reforming the financial system to support the EGD objectives. The sustainable finance policy framework has been criticised for being too complex and rigid, creating compliance problems and making regulatory breaches more probable. While there may be calls to reduce the regulatory burden of these rules, potential changes should be carefully assessed to ensure that they do not compromise the effectiveness the regulations.

Minimising uncertainty is key, as this can negatively affect the flows and investments into sustainable funds. Discrepancies in carbon accounting data and methods used by companies to draft sustainable investment strategies and assess ESG risks have also been identified. This suggests companies may have an inaccurate understanding of their emissions, while investors may underestimate their exposure to transition risk[147]. Weaknesses in the reporting of EU financial flows under the Recovery and Resilience Facility were also identified by the European Court of Auditors, who found that funding for climate action under the facility could have been overestimated by EUR 34.5 billion; they also noted that targets for circular economy and biodiversity are lacking[148].

Ensuring a broad focus beyond climate is important for meeting the wide goals of the EGD. Nature is not treated with the same urgency as the climate in the financial system, despite the fact that investments in biodiversity can complement climate investments by providing co-benefits for climate mitigation and adaptation[149].

While there are several challenges to unlocking finance for biodiversity, better integration of biodiversity considerations into existing frameworks for climate-related investments could alleviate these challenges[150]. This would reduce the EU's exposure to risks to financial stability given how closely the financial system is tied to the real economy, which in turn depends on healthy and productive ecosystems. Biodiversity investments can provide climate adaptation benefits as well — another important area for sustainable finance.

The cost of extreme weather events, which will increase in severity and frequency, also pose significant macroeconomic risks with the potential to increase government debt, economic divergence and risks to financial stability. Only about a quarter of climate-related losses are currently insured in the EU and this gap could widen in the medium to long term if not addressed. While the challenge in closing this gap is significant, EU policymakers have made progress in setting out options to tackle it[151].

Risks related to climate transition and climate-related physical risks influence banks' decisions on loan approvals and lending conditions. This influence is expected to increase going forward due to stricter supervisory and disclosure requirements. Activities with low emissions often receive climate discounts in their bank lending conditions. In contrast, credit standards for high-emitting firms are tighter and they face higher lending rates, which can slow decarbonisation efforts in hard-to-abate sectors(152).

6.3.2 Green taxation and market-based instruments

Environmental taxes encourage producers and consumers to pollute less and use resources more sustainably. They also deliver public revenues. They include: energy taxation, transport taxation, pollution and resource taxes(153). Despite the essential role environmental taxation plays in the transition to a greener economy, the share of environmental taxes in total revenues from taxes and social contributions in the EU fell from 6.0% in 2010 to 4.8% in 2022(154). A key challenge relates to the fact that as taxes disincentivise the activity subject to taxation, revenues decline(153).

The EC's recommendation on tax incentives aims to support the Clean Industrial Deal. The recommendation sets out a comprehensive framework for Member States to design cost-effective tax measures to stimulate investment in clean technologies and industrial decarbonisation.

In a recent example from a Member State, Denmark's Green Tripartite Agreement brought together stakeholders to agree on a pathway to decarbonise the agricultural sector, using the world's first carbon tax on agricultural emissions (see Box 6.18).

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Box 6.18

Greening Denmark: the transformative power of the Danish Green Tripartite Agreement

In 2024, Denmark adopted the Green Tripartite Agreement, a pioneering framework to transform agriculture while advancing national and EU climate, water, and biodiversity goals. The agreement unites government, the Danish Society for Nature Conservation, the Danish Agriculture and Food Council, and other key stakeholders.

It rests on four central goals: reducing agricultural greenhouse gas emissions by 1.8 million tons in 2030, rising to 3.3 million in 2035; achieving good ecological status for all water bodies with a 25% cut in coastal nitrogen pollution; restoring nature and biodiversity by expanding habitats and forest cover by 40%, and creating new rewilding parks; and strengthening competitiveness and rural employment, ensuring the green transition also supports jobs.

Backed by EUR 5.8 billion, the largest environmental investment in Danish history, the agreement funds the afforestation of 250,000 hectares and rewetting of 140,000 hectares of peat soils. By 2045, about 15% of farmland will be restored for ecological purposes, directly contributing to EU biodiversity and water directives.

A cornerstone is the world's first carbon tax on agricultural emissions, starting in 2030 at EUR 40 per tonne of CO_2e and rising to EUR 100 by 2035, with a 60% base deduction rewarding efficient practices. Revenues are reinvested in green technologies, research and sustainability. A carbon tax on peatlands begins in 2028.

To safeguard competitiveness, 15% of the budget is allocated to research and development, while EUR 56 million supports the Foundation for Plant-Based Food, advancing product innovation and sustainable diets. Ecosystem restoration also plays a key role, with farmland converted to wetlands and forests to boost biodiversity, reduce nutrient losses and sequester carbon. Over EUR 10 million supports the rehabilitation of marine habitat in Øresund and Lillebælt.

Recognising the social dimension, a EUR 13 million just transition fund (2027-2030) supports reskilling agricultural workers for roles in renewable energy, ecosystem restoration and sustainable food systems. Farmers and landowners are further supported through compensation, subsidies and infrastructure investments.

Implementation is locally-anchored through 23 decentralised tripartite groups that tailor national goals to regional contexts. With transparent monitoring and adaptive management, the agreement balances ambition with practical governance.

The Green Tripartite Agreement thus offers a scalable model for Europe, aligning climate action, biodiversity restoration, water management and rural development into one integrated, community-led framework. See also Denmark's country profile.

The EU ETS has been successfully driving decarbonisation of the energy and industrial sectors in Europe[73], with the prices of carbon allowances increasing ten-fold between 2017 and 2021[155]. Looking forward, the 2023 ETS revision will tighten the cap to reduce emissions by 62% by 2030 compared to 2005 levels.

From 2026, the CBAM will align the prices of cement, aluminium, fertilisers, iron and steel, hydrogen and electricity imported into the EU with goods produced in the EU, to reflect the embedded carbon emissions generated in their production.

Additionally, the electricity market rules, adopted in May 2024, are expected to reduce volatility in terms of electricity costs for companies and to support new investments in electricity generation.

Subsidies are also useful for promoting the deployment of clean technologies, where costs are initially high but fall as deployment scales up. Under the EC's Clean Industrial Deal State Aid Framework, state aid rules have been relaxed to support investments in measure to:

- accelerate the rollout of clean energy;
- support electricity costs for energy-intensive users;
- facilitate industrial decarbonisation;
- ensure sufficient manufacturing capacity in clean technologies; and
- de-risk private investments.

It is crucial to align market signals with policy goals to increase momentum, create price incentives for compliance and motivate first movers to shift the goal posts forward. EU legislation to foster electric vehicles under the clean vehicles directive while phasing out the internal combustion engine by 2035 through the zero-CO_2 emission target for new cars and vans provides a good example of such a dual approach.

The environmental liability directive operationalises the polluter pays principle in the EU (see Box 6.19). In another successful example, the application of Extended Producer Responsibility has led to an increase in recycling rates(156). Proposals have been made to extend extended producer responsibility to additional products, such as certain single-use plastics items under the directive on single-use plastics, pharmaceuticals and cosmetics under the revised urban wastewater treatment directive and textiles under the proposal for a revision to the waste framework directive.

Box 6.19

The environmental liability directive

The environmental liability directive promotes ecological restoration in the EU, operationalising the polluter pays principle to ensure that environmental damage is remediated. By obliging operators to restore damaged natural resources and ecosystem services to their baseline condition — and where that is not feasible, to deliver complementary or compensatory remediation — the directive provides a structured legal framework for restoration.

The 2023 evaluation of the environmental liability directive confirms that while it has resulted in successful remediation cases, especially in the areas of biodiversity and water-related damage, its implementation remains uneven due to variable enforcement, limited financial security instruments and narrow interpretations of key legal definitions.

While phasing out environmentally-harmful subsidies would free up finance and remove market distortions, there has been limited success in this area so far(153). The EU is not expected to make notable progress in phasing out fossil fuel subsidies by 2030, with EUR_{2023} 136 billion paid out in 2022. The sudden significant growth in 2022 fossil fuel subsidies was driven by the energy crisis, intensified by Russia's invasion of Ukraine, when Member States implemented at least 270 national measures to protect households and industries.

In 2023, 43% of total fossil fuel subsidies had a planned end-date before 2025, while a further 9% have a planned end date before 2030. Significantly, there is no current end date for 48% of fossil fuel subsidies, representing a sum of EUR_{2023} 53.1bn annually[157].

6.3.3 Accounting for nature

The value of ecosystem services and ecological resilience are not easily translated into economic costs and benefits. As such, they do not feature on business balance sheets. Unrealised value is hard to account for and cannot readily be used for investment decision-making, and this incentivises short-termism and creates a systematic bias against long-term investments in nature and climate adaptation[137].

Likewise, the environmental degradation and climatic disruption resulting from resource use in production have long been negative externalities, costs that are not borne by the producer. Indeed, while private actors generated profit by using natural resources, the environment and climate costs of resource extraction have frequently fallen on society.

There is now growing recognition that nature-related financial risks could have significant macroeconomic implications and that failure to account for, mitigate and adapt to these risks threatens financial stability[158]. In this context, financial institutions are starting to take a strategic, forward-looking and comprehensive approach to considering climate-related and environmental risks.

A recent European Central Bank guide sets out how institutions can consider climate-related and environmental risks when formulating and implementing their business strategy and risk management frameworks[159]. In terms of legal pressure, there has been an increase in climate-related litigation cases brought against states and public entities as well as financial and non-financial institutions. As climate change litigation continues to expand, it brings with it transition costs for corporations, in addition to financial and reputational implications[160].

Despite the recognition that people's well-being depends on a broad range of social and environmental as well as economic conditions, GDP and its growth remain the most important economic indicators used to gauge the overall state of an economy[129]. To progressively complement the use of GDP with well-being indicators in EU policymaking, the EC has been developing sustainable and inclusive well-being metrics; these aim to measure progress towards well-being and highlight how environmental, health and social policies contribute beyond the traditional economic perspective[161].

Most recently, the GDP3+ framework proposes three key dimensions of sustainable prosperity — namely social, environmental and institutional prosperity. Its aim is to align with public concerns by making these dimensions equal to economic concerns in high-level decision-making[162].

6.4 Securing Europe's natural wealth to deliver healthy and prosperous lives

Only by mitigating and adapting to climate change and protecting and restoring ecosystems will we be able to maintain the high quality of life of European citizens. Responsible stewardship of our natural capital can ensure that we can meet people's needs today, while also maintaining and restoring Europe's natural resources for future generations. This entails recognising that these resources provide the foundation for a prosperous, competitive, resilient and secure Europe in the future.

Climate change is a serious threat already wreaking havoc today, with urgent action needed to protect people from the impacts of droughts, floods, extreme heat and other climate impacts. Nature plays a key role in increasing resilience to climate change in Europe, especially through nature-based solutions. Sustainable solutions offer a 'triple win' by:

- mitigating environmental pollution and supporting biodiversity;
- improving the health and well-being of populations; and
- fostering social cohesion and integration.

Decarbonising the EU economy and embracing circularity will reduce the EU's dependence on imported energy and raw materials, and increase our strategic autonomy and security. This is also foreseen to create new jobs and reinforce the EU's position as a first leader on sustainability.

Looking forward, the strategic goal of a sustainable dynamic between Europe's economy and the environment must be rooted in meeting people's needs. To maintain European living standards, it will be crucial to adopt a holistic view of prosperity that goes beyond competitiveness. Rather, prosperity should encompass the quality of people's livelihoods, their health and security, as well as long-term resilience to climate and environmental pressures[163].

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List of acronyms

°C	Degrees centigrade
8th EAP	8th Environment Action Programme
AI	Artificial intelligence
CAP	Common Agricultural Policy
CBAM	Carbon border adjustment mechanism
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture, utilisation and storage
CFP	Common Fisheries Policy
CID	Clean industrial deal
CO_2	Carbon dioxide
CPR	Construction products regulation
DDT	Dichlorodiphenyltrichloroethane
EAD	Expected annual damage
EEA	European Environment Agency
EC	European Commission
ECHA	European Chemicals Agency
ECDC	European Centre for Disease Prevention and Control
EDC	Endocrine-disrupting chemicals
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
EGD	European Green Deal
EIR	Environmental Implementation Review
EMA	European Medicines Agency
ESABCC	European scientific advisory board on climate change
ESG	Environmental, social and governance
ESPR	Eco-design for sustainable products regulation
ESR	Effort sharing regulation
ETS	Emissions trading system
EU	European Union
F2F	Farm to Fork Strategy
FEC	Final energy consumption
F-gases	Fluorinated greenhouse gases
GDP	Gross domestic product
GHG	Greenhouse gas
$GtCO_2e$	Gigatonnes of carbon dioxide equivalent
GW	Gigawatts
HFCs	Hydrofluorocarbons
Hg	Mercury
IAS	Invasive alien species
ICEV	Internal combustion engine vehicle
ICT	Information and communication technology
IEA	International Energy Agency
IED	Industrial and livestock rearing emissions directive

IPCEI	Important projects of common European interest
IRP	International Resource Panel
IT	Information technology
JRC	Joint Research Centre
JTF	Just Transition Fund
LCP	Large combustion plants
LNG	Liquid natural gas
LULUCF	Land use, land use change and forestry
MFF	Multiannual Financial Framework
MSFD	Marine strategy framework directive
Mtoe	Million tonnes of oil equivalent
NDCs	Nationally determined contributions
NEC	National emission reduction commitments
NECP	National energy and climate plan
NGO	Non-governmental organisation
NH_3	Ammonia
NO_x	Nitrogen oxides
NRP	National restoration plan
NRR	Nature restoration regulation
O_3	Ozone
ODS	Ozone-depleting substances
OECD	Organisation for Economic Co-operation and Development
OPS	Onshore power supply
PAH	Polycyclic aromatic hydrocarbon
PARC	Partnership for the Assessment of Risks from Chemicals
Pb	Lead
PCB	Polychlorinated biphenyl
PEC	Primary energy consumption
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PPP	Polluter pays principle
PV	Photovoltaics
NMVOC	Non-methane volatile organic compounds
R&I	Research and innovation
R&D	Research and development
REACH	Registration, evaluation, authorisation and restriction of chemicals
RES	Renewable energy sources
RRF	Recovery and Resilience Facility
SAF	Sustainable aviation fuels
SCF	Social Climate Fund
SO_2	Sulphur dioxide
SMEs	Small and medium-sized enterprises
TW	Terawatts
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
UWWTD	Urban Wastewater Treatment Directive
WHO	World Health Organisation
y-HCH	Lindane
ZPAP	Zero pollution action plan

Note on monetary conversions and deflation calculations

For the purpose of this report, monetary values that were expressed in US dollars (USD) in source material were converted to euros (EUR) using exchange rates sourced from LSEG Data & Analytics.

Historical USD figures were converted using the exchange rate prevailing at the time the value was recorded.

For USD figures referring to future periods, projected exchange rates corresponding to the relevant time horizon were applied.

To express high volume monetary values in current euro terms , indexation was carried out using the price component of Eurostat's GDP aggregate (indicator: nama_10_gdp) as a deflator.

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Kongens Nytorv 6
1050 Copenhagen K
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Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

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