European Environment Agency

Competitive by nature

Europe's long-term competitiveness through the lens of sustainability

EEA report

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Foreword

In our conventional understanding, competitiveness and sustainability are often regarded as separate issues. Economic competitiveness can be achieved without environmental sustainability — at least for a time. However, such competitiveness often relies on the depletion of natural and social capital, whose full value is not always visible in economic frameworks.

Environmental degradation, climate instability, resource insecurity and social fragmentation may initially appear to be externalities. Eventually, however, they return as constraints on productivity, investment and resilience. As such, the costs of inaction in these areas are not absent; they are merely deferred.

At the same time, sustainability cannot be separated from economic dynamism. Politically and socially, it is difficult to sustain environmental ambitions that fail to generate innovation, investment and widely shared benefits. This means that the relationship between sustainability and competitiveness is neither a simple trade-off nor is there automatic alignment. Each increasingly becomes a condition for the other.

From this perspective, Europe's future competitiveness depends less on excelling in any single dimension than on maintaining the conditions that make long-term prosperity possible.

Across the areas examined in this report, competitiveness emerges from the interaction of several domains: decarbonisation and electrification, the circular economy and resource efficiency, nature protection and restoration, and climate adaptation and resilience.

The findings of this report therefore do not point to a single model or blueprint for Europe's future. Rather, they suggest a different way of thinking about competitiveness. In this context, the question which needs to be asked is: how can competitiveness be achieved in line with the very environmental and social conditions on which it depends for its long-term success?

In this sense, the idea of Europe being 'competitive by nature' captures more than a policy ambition. It reflects a recognition that Europe's future prosperity depends on its ability to work with — rather than against — the ecological and social foundations of its economy. The challenge is not simply to decarbonise industry, strengthen strategic autonomy, restore ecosystems or accelerate innovation. It is to govern the relationships between these objectives. Europe's long-term competitiveness will ultimately depend on how successfully it manages the tensions, dependencies and opportunities that connect them.

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Key messages

- Europe's competitiveness is being reshaped by geopolitical fragmentation, technological change, climate impacts, environmental degradation and growing competition for energy and critical resources. Past sources of competitive advantage cannot be taken for granted, and Europe's current economic performance provides only a partial indication of its capacity to prosper under increasingly uncertain future conditions.

- Europe's long-term competitiveness depends not only on productivity, investment and innovation but also on maintaining the natural, social and institutional foundations of prosperity. Circularity and resource efficiency, decarbonisation and electrification, climate adaptation and resilience as well as nature protection and restoration can reduce strategic vulnerabilities, protect productive capacity and create opportunities for innovation, investment and employment. This is the basis for becoming competitive by nature.

- This report identifies six no-regret options that hold potential for Europe's sustainable competitiveness across a range of future conditions. These are:

  - scaling up circular economy approaches and resource efficiency;
  - investing in climate adaptation, nature-based solutions and resilient infrastructure;
  - developing European capabilities in computing, artificial intelligence (AI) and next-generation biotechnology;
  - strengthening skills, education and lifelong learning;
  - supporting social cohesion, public trust and effective regulatory frameworks;
  - maintaining an active European Union (EU) role in international standard-setting and multilateral institutions.

- These no-regret options are potentially robust strategic directions. They are deeply interconnected, and their effects will depend on policy design and implementation. In order to realise their potential:

  - synergies will need to be strengthened;
  - trade-offs will need to be managed;
  - it will be necessary to prevent environmental, economic and social risks from being shifted between sectors, places and generations.

- Europe already has a substantial policy foundation supporting these directions. The strategic challenge is therefore to connect, scale up and adapt the existing efforts while maintaining a long-term perspective — creating economic value while protecting and strengthening the foundations on which Europe's future prosperity depends.

Executive summary

The decades leading to the mid-21st century are likely to be characterised by rapid technological transformation, growing economic uncertainty, demographic change and intensifying geopolitical competition. At the same time, accelerating climate change, biodiversity loss, pollution and wider environmental degradation will remain defining features of the global landscape.

These environmental pressures could amplify economic uncertainty, intensify competition for resources and contribute to geopolitical tensions. This would result in a cascading and mutually reinforcing polycrisis.

For Europe, this period of profound change will bring both challenges and opportunities. Europe's socio-economic model is shaped by decades of economic integration, social progress, democratic governance and increasingly ambitious environmental standards. However, it will face new tests of its competitiveness and resilience. Its capacity to respond will depend partly on whether environmental sustainability is treated as an integral facet of Europe's economic foundations rather than as a separate policy objective.

Over recent decades, Europe has undergone significant structural economic change. Economic activity has increasingly shifted towards services, knowledge-intensive sectors and higher-value manufacturing. Meanwhile, parts of its heavy industry and resource-intensive production have relocated abroad.

Together with technological improvements and environmental and climate policies, this transformation has contributed to reduced greenhouse gas (GHG) emissions and pollution levels. It has also enabled Europe to position itself as a leader in environmental regulation and sustainable development.

In contrast, however, it has also increased Europe's dependence on global supply chains for critical raw materials (CRMs), technologies, industrial inputs and manufactured goods. As a result, part of Europe's environmental footprint has been displaced beyond its borders. At the same time, Europe has increasingly apparent vulnerabilities related to resource security, technological dependence and industrial resilience.

The compound pressures of the coming decades are likely to test this model further. Climate change, environmental degradation, geopolitical fragmentation, technological disruption and growing competition for resources could affect productivity, investment, supply security and economic stability.

In this evolving context, competitiveness may increasingly depend on Europe's capacity to:

- anticipate and withstand shocks;
- reduce strategic dependencies;
- manage resource demand;
- maintain the natural systems on which economic activity and societal well-being depend.

At the same time, these challenges may create opportunities for economic renewal, innovation and transformation. Placing sustainability at the centre of the competitiveness agenda could help Europe to strengthen its resilience while developing new technologies, markets, infrastructure and business models.

Resource efficiency, circularity, decarbonisation, climate adaptation and the protection and restoration of natural capital can reduce vulnerabilities, strengthen supply security and support Europe's capacity to prosper under changing global conditions. In a world increasingly shaped by environmental constraints, geopolitical fragmentation and technological disruption, sustainability is becoming a foundation for long-term competitiveness.

This report explores the challenges and opportunities that could shape the EU's competitiveness up to 2040. It examines sustainable competitiveness through four interrelated dimensions:

- circularity and resource efficiency;
- decarbonisation and electrification;
- climate adaptation and resilience;
- nature protection and restoration.

Together, they provide the analytical structure for examining how sustainability could contribute to Europe's competitiveness under different future conditions.

Adopting a strategic foresight perspective, the report explores ideas about how Europe might strengthen its long-term competitiveness while preserving the environmental foundations on which it depends. It examines emerging developments, systemic interdependencies and the ways in which present-day choices could shape future risks and opportunities.

By applying this long-term, sustainability-oriented lens, the report seeks to advance more anticipatory and transformative approaches to competitiveness. These are understood in broader terms than short-term conventional economic indicators alone.

Emerging knowledge — as well as recent experience of floods, heatwaves and wildfires — increasingly highlights the extent to which our economic systems depend on stable climatic and environmental conditions. It also demonstrates how climate change and environmental degradation can progressively undermine economic performance and productivity.

This growing recognition suggests that conventional linear projections of economic development need to be reconsidered. There need to be better methods of accounting for ecological constraints, systemic interdependencies and rising uncertainty.

In a context where disruption is increasingly the norm, a sustainability lens views long-term resilience, systemic risk governance, resource demand management, social cohesion and environmental integrity as investments in competitiveness rather than constraints upon it. This approach is becoming increasingly relevant.

The foresight exercise which informs this report involved the development of five scenarios for Europe in 2040. These scenarios do not predict the future. Rather, they explore how different combinations of geopolitical, technological, economic,

social and environmental developments could affect Europe's capacity to pursue sustainability and competitiveness. Assessing possible strategic responses across these contrasting futures made it possible to identify options that appear relevant under a wide range of conditions.

Drawing on these scenarios, the analysis distils a set of six no-regret options — policy approaches that address recurring structural vulnerabilities, offer potential benefits across multiple possible futures and are capable of leveraging opportunities under different conditions. The options are:

- scaling circular economy and resource efficiency to reduce material and energy dependence;
- investing in nature-based climate adaptation and resilient infrastructures;
- developing European capabilities in computing, AI and next-generation biotechnology;
- strengthening skills, education and social fairness;
- supporting social cohesion and public trust in a stable and coherent regulatory environment;
- maintaining an active EU role in global environmental and social sustainability standard-setting and relevant multilateral institutions.

However, they should not be understood as universally beneficial or automatically successful. Their outcomes will depend on how they are designed, implemented and combined with wider policy measures.

For example, greater resource efficiency and more circular production models could reduce material dependencies, lower costs, strengthen supply security and create new business opportunities.

However, efficiency gains do not necessarily lead to lower resource use across the economy. Lower production costs and prices can stimulate additional consumption — referred to as a rebound effect; this would partly offset the environmental benefits of improved efficiency. Complementary policies may therefore be needed to ensure that improvements in efficiency also contribute to reductions in overall resource demand.

In this context, the report highlights the value of anticipatory and systemic approaches to policymaking. Strategic foresight can help decisionmakers examine assumptions, consider alternative futures and identify actions that remain relevant even in the face of uncertainty. It can also support a broader assessment of how environmental sustainability and climate resilience may strengthen Europe's comparative advantages and help future-proof its competitiveness strategy.

From this perspective, decarbonisation, circularity, nature protection and restoration as well as climate adaptation are enabling conditions. As such, they are necessary for Europe's long-term resilience, prosperity and competitiveness.

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1 Introduction

Today, Europe is in a period marked by profound uncertainty, driven by technological disruption, geopolitical tensions, environmental pressures and shifting global economic dynamics (EEA, 2024h). Under such conditions, the future is unlikely to unfold as a simple continuation of past trajectories. This calls for new types of forward-looking knowledge.

For example, investments in decarbonisation can simultaneously contribute to emission reductions, energy security and industrial transformation. Conversely, climate change, ecosystem degradation and resource dependencies can generate cascading risks for infrastructure, productivity, investment and societal resilience. These relationships mean that environmental sustainability is increasingly relevant to Europe's economic security and long-term prosperity (EEA, 2025c).

At the same time, our understanding of interdependencies between the economic, social and environmental dimensions of competitiveness continues to evolve (Marelli et al., 2026). Emerging evidence shows that economic activity is embedded in and dependent upon stable climatic and ecological systems. Climate change, biodiversity loss and wider environmental degradation are therefore increasingly recognised as systemic risks to productivity, resilience and long-term prosperity (Ceglar et al., 2024, 2025; EEA, 2025c).

These developments suggest a need to complement conventional linear projections of economic performance with approaches that can account more fully for ecological constraints, systemic interdependencies and uncertainty.

In this context, this report examines the relationship between environmental sustainability and Europe's long-term competitiveness. It takes a qualitative strategic foresight approach to complement conventional economic analysis by exploring multiple plausible future scenarios to reveal systemic interdependencies.

To achieve this, it draws together evidence from environmental, economic and social policy domains. It then identifies potential disruptions, opportunities and emerging challenges that trend-based approaches may overlook (Marchau et al., 2019).

This makes it possible to assess how developments in one domain may influence outcomes in others. Further, it allows the report to examine how such factors could reshape the relationship of competitiveness with environmental and social sustainability towards 2040.

Five exploratory scenarios are used to delineate uncertainty about the future. These are constructed based on eight contextual factors. The scenarios are not predictions or preferred pathways; they provide contrasting settings for examining how Europe's strategic position could evolve and for identifying potentially robust directions for action across different future conditions.

Against this background, the report considers what it could mean for Europe to be 'competitive by nature'. This concept describes a direction in which Europe creates economic value while maintaining and strengthening the natural systems, social cohesion and institutional foundations on which future prosperity depends.

It does not imply that sustainability automatically generates competitive advantage. Rather, it highlights the need to design and implement economic, environmental and social policies in ways that reduce vulnerabilities, maintain productive capacity and support Europe's ability to adapt in the face of uncertainty.

1.1 Europe's competitiveness — a long-term perspective connected to today's challenges

The relationship between competitiveness and sustainability is embedded in the EU's foundational objectives. Article 3 of the Treaty on European Union commits the EU to working towards the sustainable development of Europe, based on balanced economic growth, 'a highly competitive social market economy' and 'a high level of protection and improvement of the quality of the environment'.

The policy context in which these objectives are pursued has evolved rapidly over the past decade. Policymakers are facing challenges in the form of overlapping pressures arising from climate change, biodiversity loss and pollution, geopolitical tensions, economic volatility and technological developments — including AI and the growing digitalisation of economic and social activity.

These interacting pressures — sometimes described as a polycrisis — are reshaping the conditions required to maintain Europe's prosperity, security and environmental sustainability (IPCC, 2023; EEA, 2024h, 2025c; World Economic Forum, 2025).

The economic consequences of insufficient action on environment and climate risks are already becoming visible and may increase as these pressures intensify. For example, it is estimated that the economic cost of extreme heat over the summer of 2026 will total 1% of the EU's gross domestic product (GDP) for the year. This effectively nullifies the forecast 1% growth in GDP and means that the EU economy will have been stagnant in 2026 (Stegeman, de Wilde and Hobma, 2026).

Alongside the longer-term structural pressures, the EU is facing a series of more immediate challenges to its competitiveness. Over the past decade, concerns have grown about Europe's ability to compete in an increasingly contested global economy, particularly since the COVID-19 pandemic and the energy crisis triggered by Russia's war against Ukraine since February 2022.

Recent tensions in the Middle East, including disruptions to shipping through the Strait of Hormuz, have further highlighted Europe's continued exposure to external energy shocks and the potential economic consequences of geopolitical instability. The following factors have all intensified pressure on European industries:

- high energy prices;
- market distortions linked to state support in competing economies;
- global overcapacity in strategically important sectors such as steel;
- persistent gaps in innovation, the diffusion of technology and productivity growth.

At the same time, other major economies have adopted increasingly proactive industrial and technological strategies; they are strengthening their positions in areas such as clean technologies, electric mobility, semiconductors and AI.

As a result, competitiveness has become central to the current EU policy cycle. This is not only in response to short-term economic pressures but also as a reflection of deeper concerns about Europe's long-term economic resilience and strategic position in the world.

Recent high-level assessments by Mario Draghi, Enrico Letta and Sauli Niinistö emphasise the need for Europe to remain economically strong and competitive while advancing climate neutrality, strengthening security and preparing for systemic risks (Draghi, 2024; Letta, 2024; Niinistö, 2024).

Box 1.1

Key messages on competitiveness in the Draghi, Letta and Niinistö reports

Report	Key messages
Letta report (2024)	The report calls for the EU single market to be deepened and modernised as a strategic and political project. It proposes a 'fifth freedom' — alongside free movement of goods, services, capital and people — focused on research, innovation and education.
Draghi report (2024)	This report focuses on strengthening Europe's competitiveness through innovation, industrial policy, investment, digitalisation, the green transition and economic security. It highlights Europe's structural weaknesses in technology, finance and energy.
Niinistö report (2024)	The report emphasises the need to strengthen Europe's security, preparedness and resilience in response to growing geopolitical instability, hybrid threats, climate risks and systemic crises. It calls for a more integrated approach to preparedness, strategic foresight, critical infrastructure and societal resilience.

These high-level reports demonstrate that the EU's policy discourse about competitiveness is complex as they provide valuable perspectives on the role of the single market, security and preparedness.

However, they pay comparatively less attention to the role of environmental systems, natural capital and ecological resilience as underlying determinants of long-term economic performance.

Furthermore, the aspects of competitiveness that come to the fore vary depending on the level of analysis. At the level of firms and sectors, competitiveness may refer to productivity costs, innovation and market performance. At the level of an economy or socio-economic model, it can be understood more broadly as the capacity to sustain prosperity, well-being and innovation over time.

This broader understanding points to the importance of a long-term view. Short-term sectoral performance may not fully reveal the structural assets and vulnerabilities that determine whether an economy prospers under changing conditions.

This is especially relevant in the context of climate and environmental change. Many of the environmental processes that will shape future competitiveness — including climate change, biodiversity loss, ecosystem degradation, resource depletion and water stress — unfold over decades and may involve long-lasting or irreversible consequences.

Investments in energy systems, transport infrastructure, industrial facilities, urban development and ecosystem restoration likewise influence economic and environmental outcomes far beyond typical business, political and investment cycles.

These factors represent a central governance challenge: economic activity depends on ecological and climate systems, but the limits and regenerative capacities of these systems operate over much longer time horizons than those generally reflected in market signals or short-term economic indicators (Daly, 1990). Consequently, decisions that appear economically advantageous in the short term may increase exposure to future risks or lock economies into unsustainable pathways. Conversely, investments that initially entail costs may strengthen resilience, reduce dependencies and support new sources of competitiveness over time.

The relationship between competitiveness and sustainability is not simple. Nor is it automatically mutually reinforcing. For example, economic gains can be pursued through activities that increase resource extraction, pollution or inequality while externalising environmental and social costs. Such models implicitly assume that resources are abundant and that environmental systems have sufficient capacity to absorb waste and pollution.

However, economic activity takes place within a finite ecological system; natural resources, regenerative capacities and the ability to absorb pollution are constrained. From this perspective, long-term economic success depends on maintaining the environmental systems and resources on which prosperity ultimately depends (Boulding, 1966).

Historically, the economic development of industrialised economies has been associated with high levels of material and energy use. Increasingly, this approach has involved relocating resource-intensive production and associated environmental pressures beyond national borders (UNEP IRP, 2024). In Europe, a substantial share of the environmental impacts associated with its consumption now occurs outside EU territory.

This highlights the distinction between improvements in environmental performance within the EU and the wider environmental footprint of the European economy (EEA, 2026f). Economic models based on high material throughput and externalising environmental costs can generate substantial gains in the short term. However, they may also weaken the foundations of future prosperity by:

- degrading ecosystems;
- increasing resource dependencies and exposure to geopolitical shocks;
- shifting environmental and social costs onto other territories and communities.

It is in this context that Europe's competitiveness takes on a different meaning. The challenge for Europe is not simply to reduce the environmental costs of its economic activity but to change the conditions under which it remains competitive.

Europe faces twin challenges with a finite land and natural-resource base alongside high levels of consumption. The EU also remains dependent on external sources of energy and CRMs. Certain supply chains for these are concentrated in a limited number of countries.

These dependencies are exposing European economies and industries to geopolitical tensions, supply disruptions and price volatility. Resource efficiency, diversification

and circularity therefore contribute to economic security, resilience and strategic autonomy (Draghi, 2024; Niinistö, 2024; EEA, 2025c).

Despite the challenges, Europe does possess a different set of structural assets that can support a longer-term approach to competitiveness:

- established institutions;
- high levels of education and skills;
- relatively stable governance;
- strong environmental standards;
- advanced infrastructure;
- significant research and innovation capabilities;
- extensive systems of social protection.

These features contribute to resilient and innovative economies and comparatively high levels of well-being (OECD, 2022; EC, 2023b; Draghi, 2024; EEA, 2025c). They also provide a basis for a distinctive understanding of competitiveness — whereby economic performance is pursued through the development of knowledge, innovation, institutional capacity and the efficient use and recycling of scarce resources.

In this sense, Europe's relative lack of resource abundance can be regarded as a source of strategic direction. Where energy, materials, land and ecological capacity are scarce, competitiveness depends increasingly on:

- doing more with less;
- reducing exposure to external dependencies;
- extending the productive life of materials and infrastructure;
- investing in the capabilities required to adapt to changing conditions.

This raises a deeper question about what is meant by scarcity. Economic scarcity relates to the allocation of resources among competing uses; ecological scarcity refers to the biophysical limits which constrain economic activity (Daly and Farley, 2004).

This distinction is important for understanding Europe's competitive position. Technological innovation and substitution can reduce dependence on certain resources and should remain central to Europe's strategy. However, this approach cannot eliminate all forms of scarcity. Land, freshwater, ecosystem function, biodiversity and the capacity of natural systems to absorb waste and regenerate resources remain subject to biophysical limits.

As such, the relevant strategic issues are not only how Europe can secure access to scarce resources but how it can reduce its dependence on scarce inputs and increase its capacity to create value in the context of ecological constraints.

This shifts the emphasis from possession of resources to the capacity to organise, transform and renew them. Europe's competitive advantage may lie less in what

it can extract from its territory and more in what it can create through knowledge, innovation, institutions and collective action.

This report focuses on being 'competitive by nature' (defined in Box 1.2), and Europe's socio-economic model already has important strengths to support this direction. These include strong institutions, high levels of education and skills, social protection, environmental standards, research and innovation capabilities and a capacity for collective action.

Nevertheless, these strengths currently coexist with resource-intensive economic structures and consumption patterns, substantial external dependencies and increasing exposure to climate and environmental risks.

Box 1.2

What does 'competitive by nature' mean?

Competitive by nature describes an approach to competitiveness that protects and strengthens the natural, social and economic foundations of long-term prosperity. It recognises that competitiveness based on resource depletion, environmental degradation or the externalisation of social costs may deliver short-term gains while weakening resilience and productive capacity over time. At the same time, achieving sustainability depends on innovation, investment and economic dynamism.

For Europe, being competitive by nature means **creating economic value while maintaining and regenerating the natural and social capital on which future prosperity depends**.

Current attempts to promote sustainability are under pressure. High environmental standards and safeguards can conflict with forms of competition that prioritise scale, speed, low costs and rapid deployment. This is particularly true for emerging technological sectors such as AI and under conditions of intensifying geopolitical and geoeconomic competition.

It may be necessary to reduce poorly designed administrative burdens and accelerate implementation. However, any reforms that weaken institutional capacity, social cohesion or environmental resilience can also undermine competitiveness over longer time horizons.

In this context, well-designed policy can help to create the conditions for a new growth trajectory by stimulating investment, innovation and technological change. Regulation can:

- provide direction and certainty;
- shape markets and expectations;
- encourage firms to develop technologies and business models suited to an increasingly resource- and carbon-constrained economy.

The challenge for Europe is therefore to design a policy, investment and innovation framework that mutually reinforces environmental ambition and competitiveness (Stern, 2025).

Recent EU policy developments reflect elements of this shift. The competitiveness agenda of the 2024-2029 European Commission (EC) increasingly connects economic performance with long-term resilience, preparedness and strategic autonomy.

The EU Preparedness Union Strategy, for example, frames external dependencies as economic and security vulnerabilities; it emphasises risk management, strategic foresight and the capacity to respond to disruption. The Critical Raw Materials Act similarly reflects the growing recognition that industrial transformation and competitiveness depend on secure access to strategic inputs.

Energy illustrates these interdependencies particularly clearly. The disruption of pipeline gas supplies due to Russia's war against Ukraine has resulted in substantial macroeconomic costs including increased inflation, reduced household purchasing power, and lower economic growth across the EU. Meanwhile, European firms continue to face higher energy prices than several major competitors. This affects their industrial competitiveness and investment decisions.

Yet, the response to this vulnerability has also created opportunities to strengthen both resilience and sustainability. Initiatives such as REPowerEU and AccelerateEU seek to improve energy security through electrification, energy efficiency, diversification and greater coordination across Member States. This approach can simultaneously reduce Europe's dependence on fossil fuels, accelerate decarbonisation and strengthen the resilience of its energy system (EEA, 2026l).

Water provides a related example. Increasing drought, water scarcity, flooding and ecosystem degradation create risks for agriculture, industry, energy production and infrastructure. This means that water resilience is increasingly a matter of economic security as well as environmental protection (EEA, 2024g).

The EU Water Resilience Strategy connects protection and restoration of the water cycle with the development of a more water-efficient and competitive economy. It focuses on a 'water efficiency first' principle, water reuse, investment in infrastructure, innovation and digitalisation. These approaches seek to reduce demand and dependence on increasingly scarce water resources while creating opportunities for European water technologies and services.

Energy and water illustrate the same underlying shift: resources once treated primarily as inputs to economic production are increasingly understood as conditions of economic resilience. It is necessary to secure them to maintain the productive capacity of the economy in the face of increasing uncertainty. What may appear as a cost under conditions of stability can become an asset under conditions of uncertainty.

As such, the task for Europe is to develop the environmental and social foundations of its socio-economic model as sources of resilience, productive capacity and long-term economic strength. They must no longer be treated simply as constraints on competitiveness.

1.2 Key questions addressed by this report

This report focuses on three main issues:

1. **Where do competitiveness and sustainability intersect, and how could progress towards sustainability in these areas contribute to Europe's long-term competitiveness?**

Chapter 2 examines how environmental sustainability relates to Europe's productive capacity, resilience and ability to create economic value and opportunities for investment, innovation and employment. It focuses on four interconnected areas of sustainable competitiveness:

- circularity and resource efficiency;
- decarbonisation and electrification;
- climate adaptation and resilience;
- nature protection and restoration.

2. **Which factors could shape Europe's competitiveness towards 2040, and how might they evolve?**

Chapter 3 examines eight contextual factors that could shape Europe's competitiveness towards 2040. They are:

- global geopolitical dynamics;
- international peace and security;
- artificial intelligence;
- trust in public policy and regulation;
- global trade and supply chains;
- availability of CRMs;
- vulnerability and adaptation to climate change;
- electrification and future energy systems.

The expectation is that all of these factors will remain relevant, but their direction, magnitude and interaction with other developments are uncertain. As such, the chapter considers alternative trajectories and the risks, opportunities and strategic tensions they could create for Europe's long-term competitiveness.

3. **How might different combinations of future developments affect Europe's competitiveness, and which strategic options remain robust across plausible futures?**

The trajectories identified in Chapter 3 are combined through a morphological scenario approach (Box 1.3) to construct five contrasting but plausible scenarios for Europe towards 2040. The scenarios are not forecasts or preferred policy pathways. They provide exploratory contexts for considering how geopolitical, technological, economic, environmental and societal developments could interact. The full scenario narratives are presented in Annex 1.

Drawing on these scenarios, Chapter 4 presents six no-regret options considered potentially relevant across a range of future conditions. It examines how each option could contribute to the four areas of sustainable competitiveness introduced in Chapter 2. Further, it also summarises the EU policies and initiatives already supporting these directions.

The chapter concludes by considering the implementation barriers and enabling conditions identified through a Delphi survey. It also discusses the implications for Europe's ambition to become competitive by nature.

1.3 Methodological underpinnings of the report

1.3.1 Knowledge base of the report

This report is underpinned by a broad, multi-method process which was designed to address the specific questions and objectives of the study. It combines a review and synthesis of the evidence, policy mapping, expert knowledge and strategic foresight. The different strands of analysis were used in combination. The foresight process provides a structured means of exploring uncertainty and alternative futures.

Chapter 2 draws primarily on a review and synthesis of the existing evidence. This includes relevant academic and policy literature as well as current EU policy initiatives related to competitiveness. Attention is paid to a broad body of European Environment Agency (EEA) knowledge on climate change, biodiversity and ecosystem degradation, natural resources, pollution, the circular economy, societal resilience and sustainability transitions.

Relevant work from the EC — particularly the Joint Research Centre (JRC) — and other European and international organisations is also considered. This is complemented by policy-mapping studies commissioned for the report from the European Environmental Bureau and Ecologic Institute.

The review of evidence provides the foundation for the subsequent forward-looking analysis. Evidence on current and past trends, emerging developments, systemic interdependencies and potential future trajectories contributes to the long-term perspective and identification of contextual factors presented in Chapter 3. It also informs the development and interpretation of the scenarios and the identification and assessment of no-regret options described in Chapter 4.

A tailored strategic foresight process is the report's principal source of new forward-looking analysis. The aim is to develop a farsighted and anticipatory assessment of how the relationship between European competitiveness and sustainability could evolve and to complement the analysis of past and current trends with consideration of alternative future developments. The process deliberately allows for uncertainty, discontinuity and different interpretations of emerging change. The foresight process is described in detail in the following section.

The analysis recognises that competitiveness and sustainability are understood differently across disciplines, policy domains and stakeholder groups. The literature and expert engagement revealed considerable variation in how emerging developments are interpreted and in terms of whether they are seen as opportunities, risks or potential trade-offs.

Capturing this diversity is important to the analysis: a development that strengthens competitiveness in one context may increase environmental pressures or create new dependencies in another. Rather than seeking to resolve these differences into a

single view of the future, the report uses them to identify areas of uncertainty, tension and potential opportunity.

1.3.2 Foresight process

Exploratory morphological scenario analysis (Box 1.3) was considered the best-suited strategic foresight approach available for the purposes of this report. It was applied with the objective of exploring a diverse range of plausible futures and examining their implications for Europe's competitiveness and sustainability. As the future is unlikely to correspond to any single scenario, the process also sought to identify opportunities, risks and strategic options that remain relevant across different futures.

The foresight process was designed to be inclusive and participatory. It drew on expertise from different institutional and thematic backgrounds. Participants included subject-matter experts, EU institutional policymakers, civil society representatives, members of the EEA Scientific Committee and experts from the EEA's European Environment Information and Observation Network (Eionet).

This diversity helped to introduce different perspectives and assumptions into the process and allowed the analysis to explore how competitiveness and sustainability might evolve under different conditions. The aim was to:

- broaden the range of futures considered;
- test assumptions about competitiveness and sustainability;
- identify strategic options that remain relevant under uncertainty.

Box 1.3

What is a morphological scenario approach?

A morphological scenario approach is a structured foresight method used to explore how different future developments may interact and combine to create alternative pathways. Morphological analysis was originally developed as a method for analysing complex systems; it seeks to identify the full range of possible configurations of a system by decomposing it into key dimensions and exploring combinations of their possible states (Zwicky, 1967).

In futures studies, this approach has been further developed as a way to construct scenarios by combining alternative assumptions about the evolution of multiple drivers of change (Godet, 2001; Voros, 2003). A morphological approach identifies key factors that may influence future developments and defines a range of possible projections for each factor. These projections are then systematically combined to explore different configurations of the future. Through an assessment of compatibility and internal coherence, combinations that are considered inconsistent or implausible can be excluded. This allows a smaller number of coherent and meaningful scenarios to be developed (Ritchey, 2011).

The strength of the approach lies in its ability to capture interactions between multiple uncertainties and avoid analysing drivers of change in isolation. It supports the exploration of a broad 'space of possibilities' and helps identify how different developments may reinforce or constrain each other over time (Godet, 2001; Ritchey, 2011).

The foresight horizon for this report was set at 2040. This timeframe is sufficiently distant to capture the structural **transformations** associated with:

- circularity and resource efficiency;
- decarbonisation and electrification;
- climate adaptation and resilience;
- nature protection and restoration.

At the same time, it allows the analysis to remain closely connected to existing European policy objectives and planning cycles. The foresight process comprised five main steps, followed by a synthesis of the findings (Figure 1.1).

Step 1: Horizon scanning and context analysis

The process began with a review of trends, emerging developments, uncertainties and potential disruptions that could influence Europe's competitiveness and sustainability towards 2040. This exercise drew on the academic and policy literature, European Commission foresight work, policy mapping and the EEA knowledge base. It generated a broad portfolio of potential contextual factors. These factors were subsequently reviewed and refined through expert engagement. The resulting set of contextual factors is presented in Chapter 3.

Step 2: Scenario development

A dedicated scenario workshop held in May 2025 brought together policymakers from EU institutions and experts from the EEA, consultancies, think tanks and academia to identify key contextual factors and develop five integrated scenarios for Europe in 2040. The scenarios — described in detail in the annex — are qualitative narratives describing alternative but plausible combinations of social, economic, technological, environmental and geopolitical developments.

Rather than predicting the future, they provide a structured framework for examining how different configurations of drivers, constraints and enabling conditions could affect Europe's competitiveness and sustainability. They also serve as a means of surfacing and challenging assumptions about how these relationships might evolve.

The scenarios were used in a participatory process to identify recurring vulnerabilities (e.g. dependence on imported energy, materials and technologies; exposure to climate and environmental disruption) as well as opportunities associated, for example, with resource efficiency, resilient infrastructure, innovation, institutional capacity and international cooperation.

Participants compared the opportunities, vulnerabilities and strategic tensions arising across the five scenarios. They were then asked to consider which strategic directions could support competitiveness and sustainability under these contrasting future conditions. This helped to distinguish options that depended heavily on a particular scenario from those considered relevant across a broader range of plausible futures.

Step 3: Identification of no-regret options

Insights from the scenario analysis were synthesised to identify potential 'no-regret' options (defined in Box 1.4). These are strategic actions that could strengthen Europe's long-term competitiveness across multiple plausible futures rather than actions tailored to a single expected trajectory. This reflects the assumption that the future is likely to combine elements of several scenarios rather than corresponding to any one of them.

Box 1.4

No-regret options in strategic foresight

In strategic foresight, no-regret options are policies, investments or actions that could generate benefits under a wide range of plausible future conditions. Unlike strategies that depend on a particular forecast proving correct, they represent potentially robust choices which remain relevant across many future scenarios (Chakraborty et al., 2011).

No-regret options can be combined and adapted as conditions change. Their purpose is to support decision-making in the face of uncertainty, reveal possible synergies and trade-offs as well as identify areas where action could strengthen preparedness and long-term resilience.

The term does not mean that these options are cost-free, universally beneficial or guaranteed to succeed. Their effects will depend on how they are designed, sequenced and implemented. They will also depend on the wider policy context and on how the costs and benefits are distributed and the safeguards are applied.

Step 4: Future-oriented expert survey

The horizon scanning and scenario analysis were complemented by a Delphi-style survey prepared for the EEA's Eionet groups and the EEA Scientific Committee. Between June and August 2025, 37 experts assessed nine forward-looking statements concerning selected outcomes associated with Europe's competitiveness and sustainability towards 2040. The statements were informed by the no-regret options and relevant EU strategic policy objectives.

The survey provided an additional expert assessment of the feasibility of selected long-term outcomes and the factors that could enable or constrain them. The findings helped to identify recurring implementation barriers, uncertainties and enabling conditions across the four domains examined in the report.

Step 5: Thematic deep dives and a futures dialogue

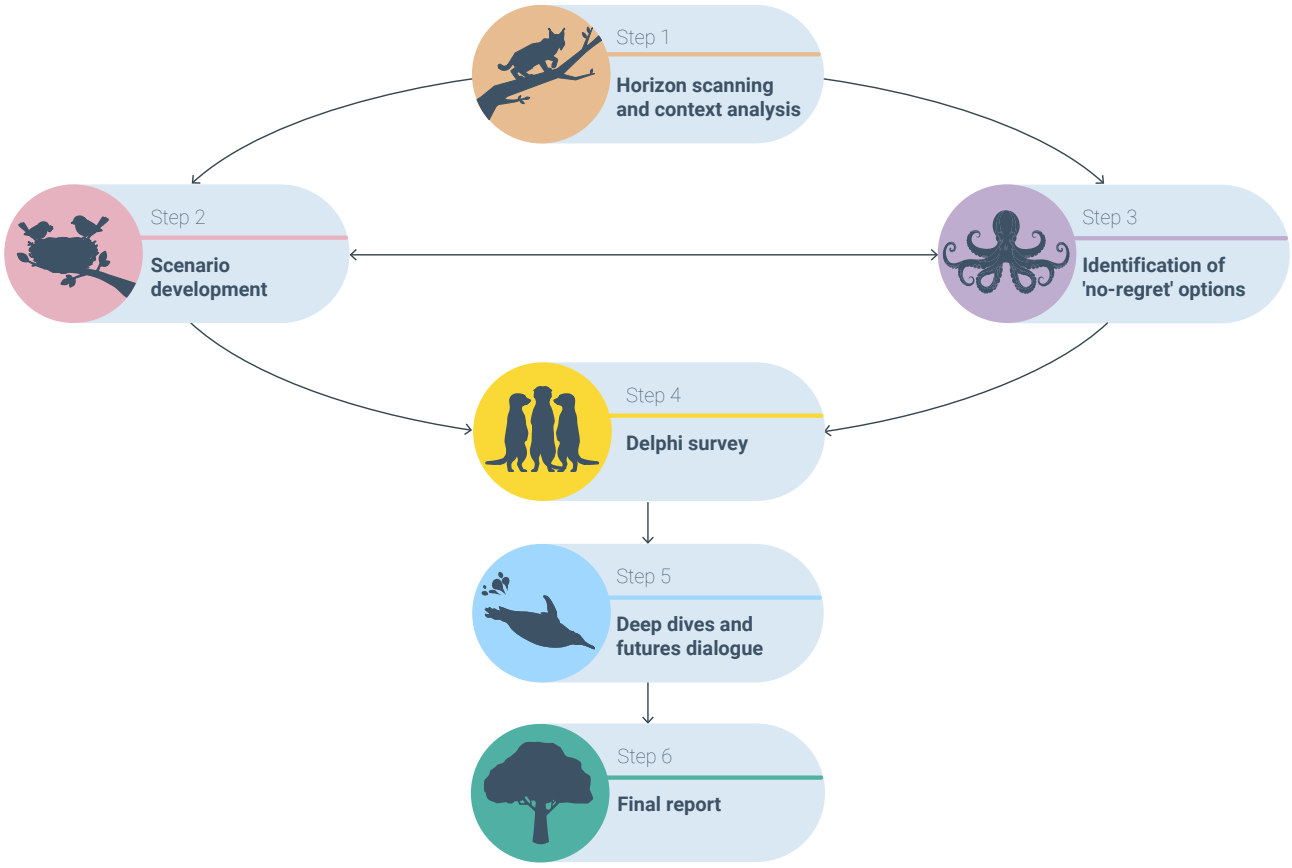
The no-regret options were examined further through thematic in-house workshops held from June to September 2025 and a futures dialogue workshop involving experts and EU policymakers (including from the EC's Directorate-General for Climate Action and Directorate-General for Environment) held in October 2025.

These workshops explored key tensions, trade-offs and implementation challenges and helped refine the policy implications of the analysis. Together with the Delphi survey, they also provided an opportunity to consider how the no-regret options could contribute to progress in the four areas where competitiveness and sustainability intersect.

The foresight process was designed and implemented in collaboration with the European Topic Centre on Sustainability Transitions (ETC ST), which produced a technical report documenting the methodology, process and foresight materials underpinning the analysis (Kimpeler et al., 2026). Earlier drafts of the report were also reviewed and discussed with experts from the Cambridge Institute for Sustainability Leadership (CISL).

Figure 1.1 summarises the activities undertaken during the foresight process.

Figure 1.1 The foresight process activities



Source: EEA own elaboration.

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2 Rethinking EU competitiveness through the lens of sustainability

Europe's socio-economic model is being reshaped by structural pressures extending well beyond short-term economic and policy cycles. Demographic change, geopolitical instability, technological transformation and environmental degradation increasingly interact in ways that affect Europe's capacity to maintain productivity and prosperity.

At the same time, dependence on imported energy and materials, accelerating climate change and deteriorating ecosystems are changing the conditions under which European firms and economies operate (Draghi, 2024; EEA, 2024a, 2025a; Niinistö, 2024).

These developments call for a broader perspective on the foundations of competitiveness (CISL, 2024). Productivity, investment, innovation and cost competitiveness remain central. However, their evolution increasingly depends on the resilience of the environmental, social and institutional systems within which economic activity takes place.

Natural capital provides resources and ecosystem services. Human and social capital support skills, cooperation and adaptive capacity. Meanwhile, institutions enable societies to respond to shocks and manage structural change. If these foundations deteriorate then economic activity can be constrained. Conversely, if they are maintained and strengthened then this can support resilience and long-term productive capacity (Dasgupta, 2021; EEA, 2024b, 2025c).

This chapter therefore examines Europe's competitiveness through the lens of sustainability. Section 2.1 considers how the economic foundations of Europe's competitiveness are changing. Section 2.2 then examines four interconnected domains through which sustainability and long-term economic performance interact:

- circularity and resource efficiency;
- decarbonisation and electrification;
- climate adaptation and resilience;
- nature restoration and protection.

These domains capture different ways in which environmental conditions and economic performance are becoming increasingly interdependent. They are neither exhaustive nor separate policy agendas. They cut across economic sectors and value chains and interact in ways that can generate synergies as well as trade-offs.

For example, circularity can reduce the material and energy requirements of decarbonisation. Meanwhile, nature restoration can support climate resilience. Conversely, poorly coordinated action can create new resource dependencies, shift environmental pressures or reinforce existing vulnerabilities.

The analysis does not assume that progress in these dimensions will automatically produce competitive advantage. Its purpose is to examine how they could protect productive capacity, reduce strategic dependencies and create opportunities for investment, innovation and employment. This all depends on how policies and investments are designed and implemented.

2.1 The shifting economic foundations of Europe's competitiveness

Recent strategic assessments converge on a common finding: several of the conditions supporting European economic growth during previous decades are weakening or changing. Europe faces subdued productivity growth, demographic ageing, increasing geopolitical competition and growing concerns around access to energy, technologies and CRMs (Draghi, 2024; EC, 2024a; EIB, 2024; IMF, 2025). These pressures are occurring alongside changing global value chains and increasing fragmentation of the international trading system (Gaál et al., 2023; Arjona, Herghelegiu and Connell García, 2024).

Environmental pressures are compounding these challenges. Climate change, biodiversity loss, pollution and resource degradation can affect infrastructure, production, labour productivity and supply chains. Meanwhile, competition for energy, land, water and materials can increase costs and strategic dependencies (IPCC, 2023; Ceglar et al., 2024; UNEP IRP, 2024).

These developments suggest that the determinants of competitiveness increasingly extend beyond production costs and efficiency to include resilience, resource and energy security, adaptive capacity and the ability to sustain productivity under changing environmental and geopolitical conditions.

2.1.1 Productivity and investment constraints in a more competitive global context

Since the global financial crisis, the growth in labour productivity in the EU has remained subdued. Meanwhile productivity in Europe has not increased to the same extent as it has in the United States. Europe has also fallen behind in key digital technologies, particularly cloud computing, AI and advanced semiconductors. Further, it faces growing competitive pressure in the clean technology and electric vehicle sectors (Ceglar et al., 2024; Draghi, 2024; Eurostat, 2026c).

While investment in digital technologies has increased, their diffusion across firms, sectors and regions remains uneven. This limits the extent to which technological change translates into aggregate productivity gains (Draghi, 2024; EIB, 2026).

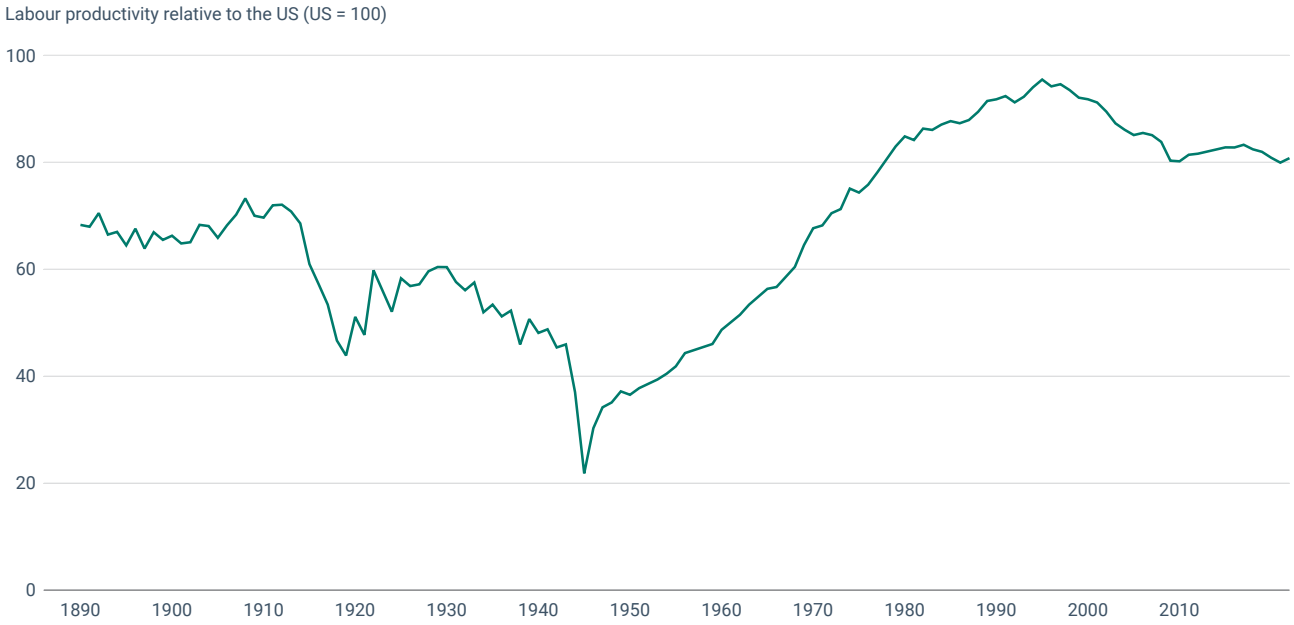
At the same time, competitive pressures have intensified globally. The share of sectors in which China competes directly with euro-area exporters increased from 25% in 2002 to almost 40% in 2023 (Ceglar et al., 2024). Meanwhile, EU labour productivity fell from around 95% of the US level in 1995 to below 80% in 2022 (Figure 2.1). This partly reflects Europe's weaker performance in capturing productivity gains from the digital economy. Europe's position in advanced technologies has also weakened, with relatively few of the world's largest technology companies headquartered in the EU (Draghi, 2024).

According to an EC assessment, the intensity of the EU's research and development remains low. At the same time, innovation outcomes and digital uptake, particularly among small and medium-sized enterprises (SMEs), remain uneven (DG Grow, 2026).

Investment capacity is therefore becoming increasingly important. European Investment Bank (EIB) analysis suggests that meeting Europe's investment needs relating to digitalisation, decarbonisation and security will require a sustained increase in investment, improved mobilisation of private capital and stronger coordination of public investment (EIB, 2026).

The composition and durability of investment also matter. This is due to the fact that today's infrastructure, industrial facilities and technologies will shape Europe's energy use, material demand and exposure to climate risks for decades.

Figure 2.1 EU versus US labour productivity 1890-2022



Notes: Reconstructed using the data presented in the Draghi report. The EU is represented by a proxy based on historical national accounts data for Germany, France, Italy, Spain, the Netherlands, Belgium, Ireland, Austria, Portugal, Finland and Greece. The labour productivity estimates draw on five data series: GDP, capital stock, employment, average hours worked and population.

Source: Based on Draghi, 2024.

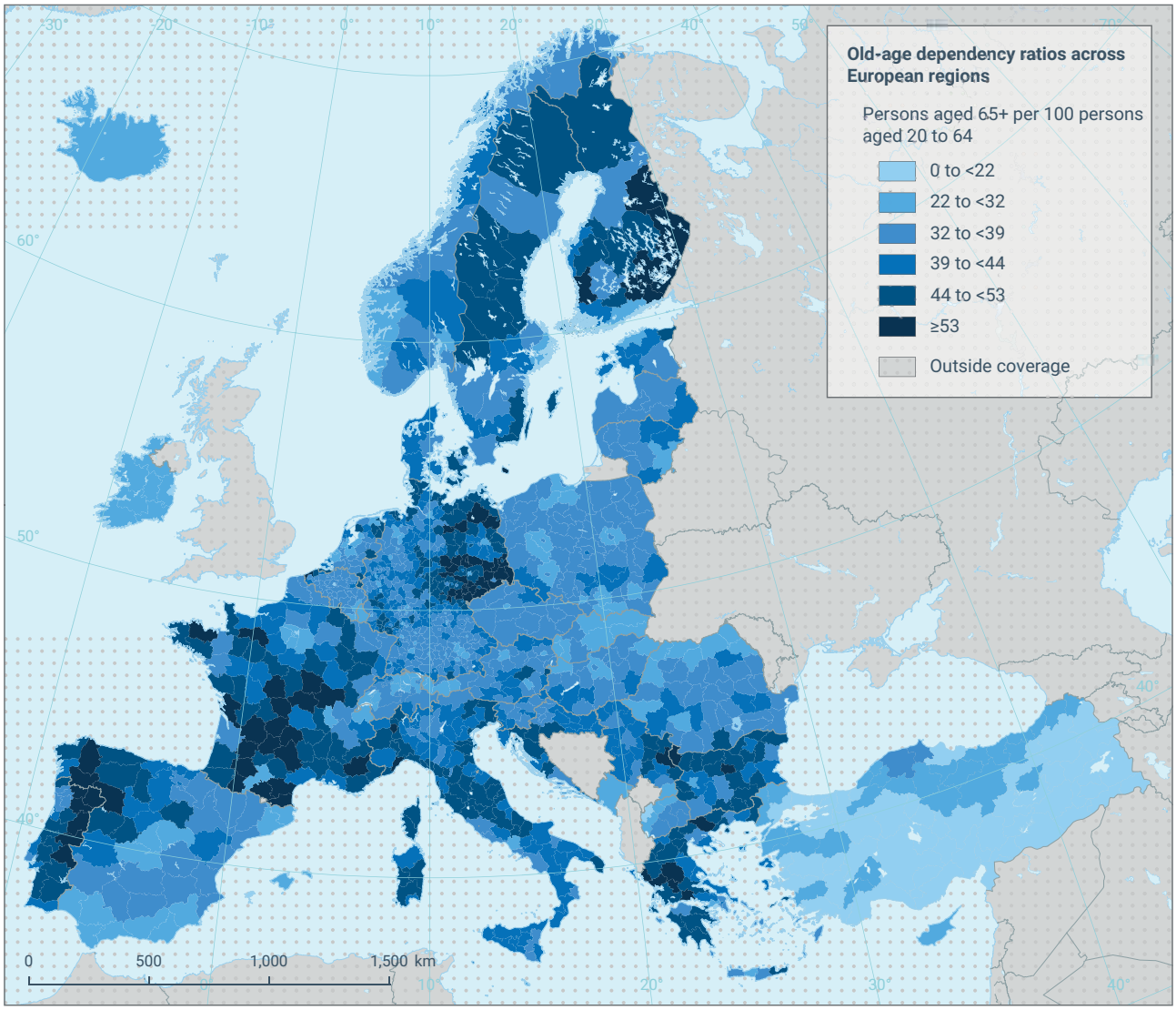
2.1.2 Demographic ageing and tightening fiscal space

Demographic change is also becoming a structural constraint in the EU. Population projections indicate that the working-age population is shrinking and that old-age dependency ratios [1] are rising across much of the EU (Figure 2.2). This is reducing labour supply and placing increasing pressure on welfare systems and public finances.

As such, by 2040, sustaining economic growth will depend increasingly on productivity gains and higher labour-market participation, including among older workers. Meanwhile, skill shortages may become more acute in some sectors (Eurostat, 2020; EC, 2023d, 2024a; Draghi, 2024).

(1) The old-age dependency ratio is calculated as the number of people aged 65 years and over divided by the number of people aged 20-64, expressed as a percentage.

Figure 2.2 Old-age dependency ratios across European regions



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

Notes: This map shows old-age dependency ratios across European NUTS 3 regions in 2024, based on Eurostat data. The old-age dependency ratio compares the population aged 65 and over with the population aged 20–64. A higher ratio indicates a larger share of older people relative to the working-age population.

Source: Eurostat, 2026b.

These developments will add to mounting pressures on public finances. According to EC analysis, population ageing will translate into sustained pressures on expenditure — particularly in the areas of pensions, healthcare and long-term care — although their scale and composition will vary across Member States.

These pressures will also coincide with the need to provide substantial finances for climate mitigation and adaptation, defence, infrastructure as well as technological and industrial transformation. Together, these competing demands may constrain fiscal space and sharpen trade-offs over public investment priorities (EC, 2024a; IMF, 2025; EIB, 2026) [(2)].

(2) Fiscal space refers to the room available in public budgets to finance additional spending or investment without creating unsustainable levels of public debt or deficits.

Broader social and environmental conditions also affect the supply of labour and productive capacity. Health inequalities, unequal access to skills and services as well as environmental exposures can constrain human capital and people's capacity to participate in the labour market. Air pollution, noise, harmful chemicals and climate-related hazards all have health and economic costs; they can lead to premature mortality, illness, healthcare expenditure, lost working days and reduced labour productivity (EEA, 2020, 2024j).

Recent EEA analysis of employment in the EU's clean tech sectors indicates that skill shortages could constrain the deployment of clean energy technologies. Meanwhile, young people and women are under-represented in parts of the clean tech workforce. Young people can bring new skills to the sector, particularly at a time when digitalisation and AI are becoming critical enablers. Equally, increasing women's participation and enabling older workers to remain in employment can help expand the available workforce and retain valuable expertise (EEA, 2026d).

Disparities in job quality across the value chain — for example, in terms of remuneration, employment status and contractual stability, physical risks and worker health and safety — directly affect recruitment and retention in occupations that are already experiencing acute shortages. These challenges undermine both climate and competitiveness goals. This is in a context where the clean tech sector (wind, solar photovoltaics (PV), batteries and heat pumps) is projected to employ hundreds of thousands of workers by 2030 (EEA, 2026d).

These observations highlight the fact that social cohesion and environmental health are not separate from competitiveness: they affect productive capacity, institutional trust and the ability to maintain support for long-term reforms.

2.1.3 Economic security

Recent crises have demonstrated that economic interdependence can create vulnerabilities when strategically important resources, technologies or energy supplies are concentrated in particular geographical areas. EU analyses increasingly connect competitiveness with economic security, diversification and the management of strategic dependencies (Gaál et al., 2023; Arjona, Herghelegiu and Connell García, 2024; Niinistö, 2024).

EU competition with China is intensifying in areas including clean technologies, batteries and CRMs. Further, other major economies are pursuing more interventionist industrial policies. These changes are reshaping global trade and investment patterns and the very foundations of competitiveness (Draghi, 2024).

The COVID-19 pandemic and Russia's war against Ukraine have exposed European vulnerabilities in energy and supply chains. In turn, they have led to sharp price increases and demonstrate the economic costs that can arise from strategic dependencies (EEA, 2024e; Systemiq, 2026).

Economic security is thus becoming an important condition for Europe's productive capacity and long-term competitiveness. Economic security is understood here as the capacity to protect and sustain economic stability and productive capacity by strengthening resilience to internal and external threats (OECD, 2025a).

In the EU framework, this encompasses risks to supply-chain resilience, critical infrastructure and technology security. It also includes risks arising from economic coercion and the weaponisation of dependencies (EC, 2025e). In this context,

the affordability of essential inputs is no longer the only issue; there are also concerns around whether access to energy, CRMs and key technologies is secure, predictable and resilient to disruption. These conditions increasingly shape industrial performance, investment decisions and the capacity of firms to plan for the long term.

2.1.4 The material intensity and footprint of Europe's economy

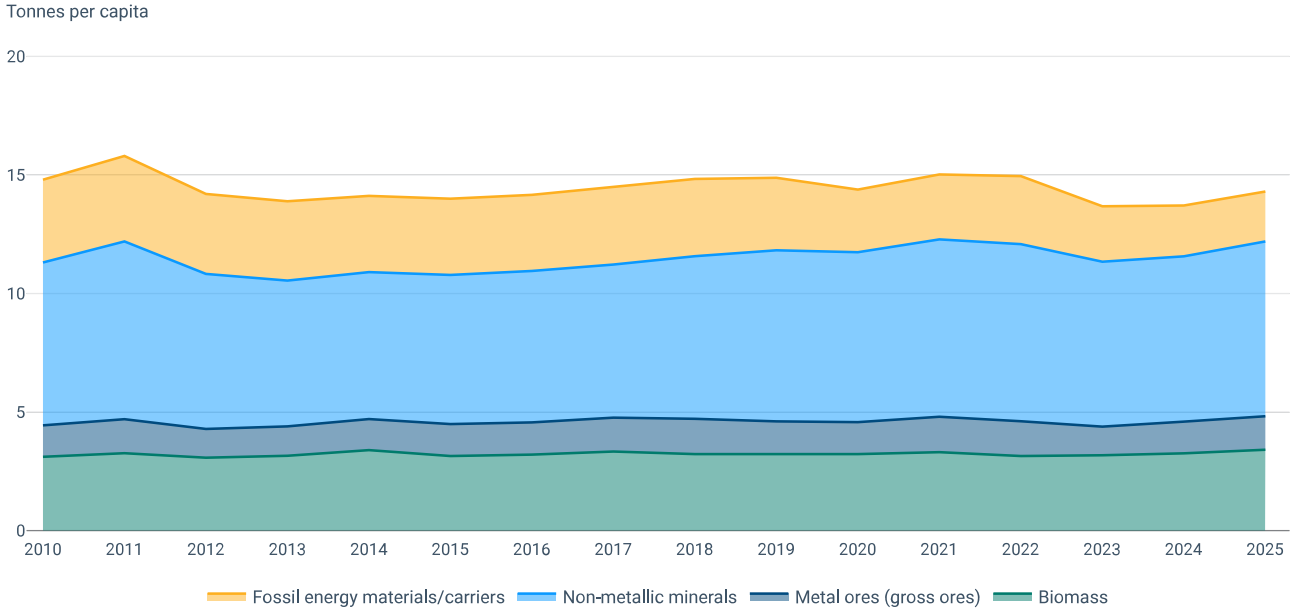
Despite improvements in resource productivity, Europe's economy remains dependent on large material flows. These are required to sustain consumption and the EU's physical asset base, including buildings, infrastructure and machinery. In 2022, around 3.21 gigatonnes (Gt) — approximately 39% of processed materials — were used for building up, maintaining and operating material stocks; construction and infrastructure accounted for the largest share (EEA, 2025a).

These stocks contribute to productive capacity but can also create long-term resource dependencies and lock-ins. Materials embedded in buildings, infrastructure and machinery remain unavailable for recycling for extended periods. At the same time, expanding stocks generate continuing demand for resources and energy to support their use, maintenance, refurbishment, and eventual replacement. These stock-flow relationships are increasingly recognised as important determinants of future material and emissions pathways (Pauliuk et al., 2021; EEA, 2024b, 2025a; UNEP IRP, 2024).

Figures for Europe's material footprint complement the statistics on material stocks by taking a consumption-based perspective; they account for raw materials extracted globally to produce goods and services consumed in the EU, including resources embodied in imports.

The EU material footprint stood at 14.3 tonnes per capita in 2025. Although almost 10% lower than in 2011, it remains above the global average and at a level considered environmentally unsustainable (EEA, 2025e). Moreover, excluding short-term fluctuations, the reductions have been limited and current trajectories do not indicate that the footprint will decrease substantially over the coming decade (Figure 2.3).

Figure 2.3 **Europe's material footprint, expressed in tonnes of raw material equivalent per capita, 2010-2025**



Note: The footprint is expressed in tonnes of raw material equivalent per capita.

Source: EEA, 2025e.

The material footprint also reveals the extent to which European consumption relies on resource extraction outside the EU. In 2019, materials extracted abroad accounted for 53% of the EU's material footprint. This contrasts with the much lower share of imported materials captured by conventional domestic material consumption measures (EEA, 2024a). This connects Europe's consumption patterns to environmental impacts and resource dependencies along international value chains (EEA, 2024i; UNEP IRP, 2024).

The EU's high primary material demand contributes to climate change, biodiversity loss and pollution, both within and outside Europe. The EU's GHG footprint — the emissions 'embodied' in products (goods and services) for final use in the economy — is higher than its production-based emissions. This means it is a net importer of GHG emissions. In 2023, global GHG emissions induced by EU consumption were 21% higher than its production-based emissions (Eurostat, 2026a).

Relying on global resource flows can mean that parts of European industry are exposed to supply disruptions and price volatility. CRMs are of particular concern in this sense — although their strategic importance cannot be inferred from aggregate material-footprint measures because many occur in relatively small physical quantities.

JRC analysis of 15 technologies across five strategic sectors illustrates both the concentration of supply and the expected growth in demand. In 2020, China supplied 60% of refined cobalt globally, 69% of refined lithium and was responsible for 93% of battery-grade graphite production. Meanwhile, in 2021 the EU had no domestic capacity to refine lithium or graphite for batteries. At the same time, EU demand for lithium used in batteries is projected to increase 12-fold by 2030 and 21-fold by 2050 compared with 2020 under a high-demand scenario (Carrara et al., 2023).

Against this background, generating greater economic and societal value from fewer primary resources — by reducing demand, improving resource efficiency and circularity as well as substitution — could reduce environmental pressures and some forms of external dependency. These approaches would complement measures to diversify and secure the supply of strategically important materials (OECD, 2019; EEA, 2024b; UNEP IRP, 2024).

2.2 How sustainability can support Europe's long-term competitiveness

Sustainability encompasses interconnected economic, social and environmental dimensions. A productive and competitive economy is essential to support Europe's capacity to invest in social and environmental objectives. At the same time, long-term economic performance depends on healthy and resilient natural systems.

For example, Europe relies on nature not only for raw materials but also for water regulation, pollination, soil fertility, climate regulation, flood protection and other ecosystem services. These systems must be able to regenerate, absorb disturbances and continue supporting economic activity and human well-being (IPBES, 2019; Dasgupta, 2021).

Empirical evidence illustrates the scale of the EU's economic dependence on nature. European Central Bank (ECB) analysis indicates that 72% of euro-area companies are highly dependent on at least one ecosystem service. Meanwhile, a substantial share of bank lending goes to firms dependent on natural resources and ecosystem services (Boldrini et al., 2023; Ceglar et al., 2024, 2025).

Eurostat estimates that 10 ecosystem services generated annual benefits of approximately EUR 234 billion across all 28 Member States in 2019 (Eurostat, 2021). More recent estimates suggest that up to 36% of EU gross value added is significantly dependent on nature (Hirschbuehl et al., 2025).

Environmental conditions are therefore essential to Europe's productive foundations rather than external considerations to be addressed after economic objectives have been pursued (EEA, 2024h, 2025c). Functioning ecosystems, stable climatic conditions and secure access to energy and materials support production and investment.

Conversely, if they deteriorate, this can generate costs and systemic vulnerabilities. For example, during the 2018 drought, a full month of low water levels on the Rhine reduced inland shipping volumes by about a quarter and German industrial production by roughly 1%. This shaved an estimated 0.3% off growth in GDP for the year (Brzeski, 2026).

Such impacts illustrate how environmental resilience can strengthen adaptive capacity and investment security by reducing exposure to disruption and long-term liabilities. The EEA reports *Europe's sustainability transitions outlook* and *Europe's environment 2025* similarly emphasise that environmental resilience, prosperity, security and competitiveness are interconnected. The reports point to the need for transformations of production and consumption systems to address climate change, biodiversity loss, pollution and unsustainable resource use (EEA, 2024h, 2025c).

Against this background, the following sections examine four interconnected domains for sustainable competitiveness:

- circularity and resource efficiency;

- decarbonisation and electrification;
- climate adaptation and resilience;
- nature restoration and protection.

Progress in these areas could reduce vulnerabilities and create economic opportunities. However, the outcomes will depend on policy design, investment, implementation and the management of trade-offs.

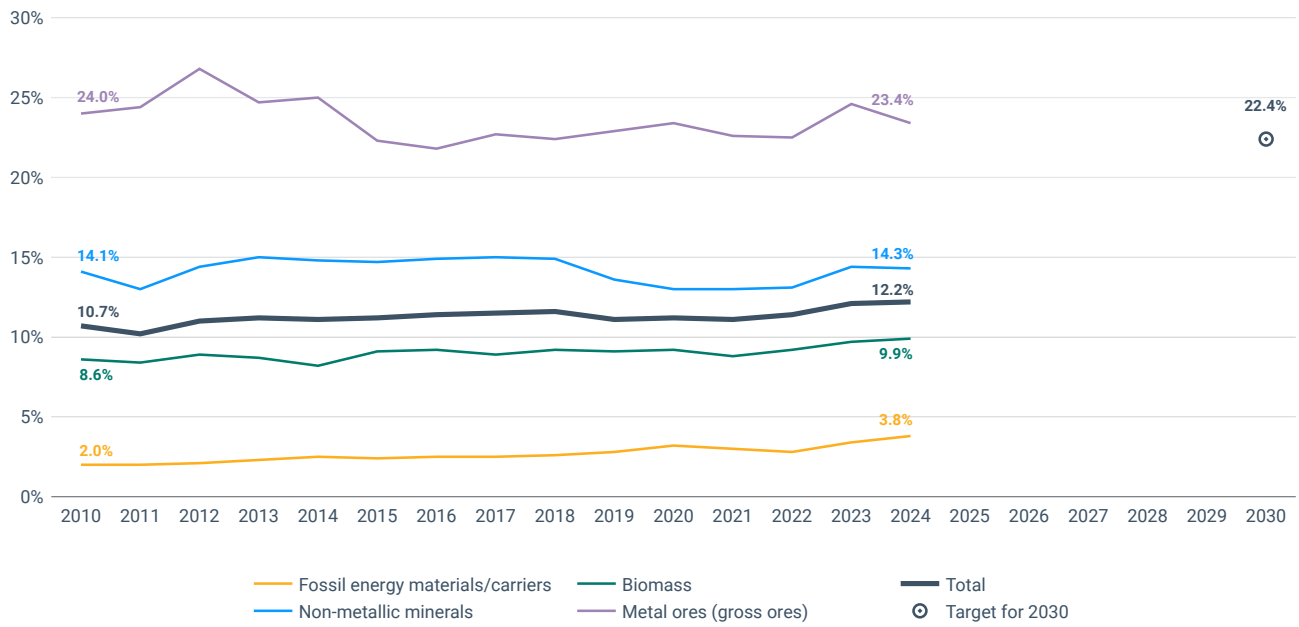
2.2.1 Circularity and resource efficiency

The first domain concerns the relationship between material use and creating economic value. Greater circularity and resource efficiency can reduce Europe's dependence on primary resources, imported raw materials and volatile commodity markets.

Europe is relatively efficient at generating value from resources and recycles almost half of its waste (EEA, 2026r). Nevertheless, linear production and consumption remain dominant. The EU economy still relies heavily on virgin materials and is dependent on materials extracted elsewhere in the world.

The EU has achieved limited progress in increasing the circular material use rate, which is a measure of the share of total material use supplied by recycled materials (Figure 2.4). However, the rate has increased only modestly, from 10.7% in 2010 to 12.2% in 2024. This means that the EU is off track to achieve its objective of doubling its 2020 circular material use rate to 22.4% by 2030 or the more ambitious 24% target set out in the Clean Industrial Deal (EEA, 2024b, 2025f).

Figure 2.4 Circular material use rate in the EU and breakdown by material group, 2010-2024



Source: Eurostat.

Material stocks — the materials embedded in long-lived assets and products such as buildings, roads, infrastructure, machinery, vehicles and appliances — form the physical basis of Europe's economy and society. EU material stocks nearly tripled between 1970 and 2022, reaching 344 tonnes per person; buildings and infrastructure accounted for 98.5% of the total.

Building, operating, maintaining and replacing these stocks requires substantial quantities of materials and energy; material inputs for these purposes alone amount to around 6.2 tonnes per person annually. As assets reach the end of their service lives, they could become important domestic sources of secondary raw materials, providing materials such as metals, concrete and aggregates that can be recovered and used in new buildings, infrastructure and manufactured products.

Realising this potential will require better information about their composition, condition and location. It is also reliant on circular design, product and material passports, selective deconstruction, high-quality recovery processes and economically viable markets for reused and recycled materials (EEA, 2026j).

As such, circularity is more complex than simply improving waste management. Extending product lifetimes — by improving their durability and through maintenance, repair, reuse and remanufacturing — can preserve value, reduce resource demand and support new markets and services. High-quality recycling and better-functioning secondary raw-material markets are also important.

However, it is the case that recycled materials frequently face constraints relating to price, quality, supply continuity, technical specifications and weak demand (EEA, 2024b). As such, circular business models remain largely confined to niches and require supportive regulation, technological and social innovation, finance, behavioural change and collaboration across value chains to reach a point where they are transformative in scale (EEA, 2026m).

Scaling circularity could strengthen industrial resilience and economic security by reducing primary material and energy demand. It would mean that value is retained within the European economy and would limit exposure to volatile global markets by decreasing reliance on externally extracted materials. EEA modelling indicates that combined circular interventions across food, housing, mobility and consumer goods could significantly reduce pressures on climate and air quality (EEA, 2026q, 2026p).

Increasing circular material use is also an important strategy for biodiversity protection, as resource extraction causes significant ecosystem disruption through habitat destruction and pollution. The environmental benefits of circularity serve to further underpin competitiveness by safeguarding natural capital and ecosystem services and boosting resilience to resource shortages and climate change impacts.

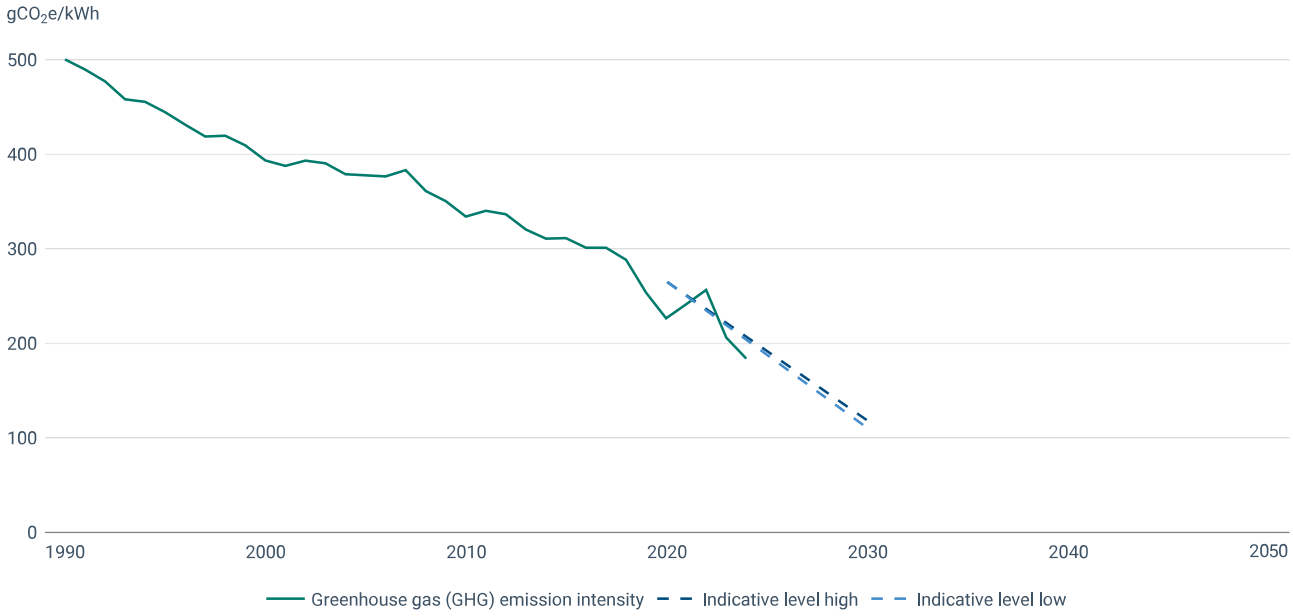
2.2.2 Decarbonisation and electrification

Electrification is a central component of decarbonisation across transport, buildings and parts of industry, alongside energy efficiency, renewable energy and other low-carbon solutions (EEA, 2025h). Europe's dependence on imported fossil fuels has demonstrated how geopolitical shocks in energy systems can affect industrial costs, household expenditure and macroeconomic performance.

Decarbonisation and electrification — when accompanied by increased generation of low-carbon electricity, grids, storage and energy efficiency — can reduce exposure to fossil-fuel imports and price volatility. They can also support the development of new technologies, infrastructures and industrial capabilities.

This transformation is already visible in the declining GHG intensity of EU electricity generation (Figure 2.5). In 2024, emissions per kilowatt-hour were 63% lower than in 1990 and 11% lower than in 2023. This reflects the continued expansion of renewable electricity and declining use of coal. Nevertheless, the pace of decarbonisation must increase further to align with the EU's 2030 and 2050 climate objectives (EEA, 2026l).

Figure 2.5 GHG emission intensity of electricity generation in the EU, 1990-2024, including indicative levels consistent with EU climate targets



Note: gCO_2e/kWh, grams of carbon dioxide per kilowatt-hour.

Source: EEA, 2026g.

The transformation itself entails substantial investment and creates new dependencies — particularly for CRMs, grids and clean technologies. The implications for competitiveness therefore depend partly on how energy, material and industrial transformations develop together. Electrification that relies on material-intensive technologies, such as batteries, electric vehicles and renewable energy infrastructure, reinforces the importance of resource efficiency, circularity and diversified supply chains, as these technologies require significant quantities of minerals and other raw materials.

Electrifying transport, buildings and suitable industrial processes can also increase energy efficiency and reduce GHG emissions and air pollution; this is provided that electricity generation is progressively decarbonised. Realising these benefits requires accelerated deployment of renewables, stronger grids, interconnection, storage, demand response and other solutions to promote flexibility. These measures must be capable of balancing a more variable and decentralised electricity system (EEA and ACER, 2023; EEA, 2025h).

Heating and cooling — which account for around 40 to 50% of EU final energy use — remain particularly significant. Addressing their impact requires a combination of energy conservation, building renovation, heat pumps, renewable heat and efficient district systems (EEA, 2023c).

Transformation of the energy system is also inseparable from industrial transformation (EEA, 2026n). Access to competitively priced low-carbon electricity, together with electrification and new low-carbon production processes, could support the decarbonisation of energy-intensive sectors and the development of clean industrial value chains.

Modelling of the European energy system identifies widespread electrification as a robust feature of net-zero pathways, complemented by the use of hydrogen and other low-carbon fuels in industrial applications that are difficult to electrify directly (Van Der Zwaan et al., 2025).

Material efficiency and circularity can further reduce the scale of energy and industrial transformation required. This illustrates the complementarities between the first two domains (Pauliuk et al., 2021). These relationships are reflected in the Clean Industrial Deal, which explicitly connects industrial decarbonisation, affordable clean energy, circularity and competitiveness (EC, 2025b).

These potential advantages involve trade-offs. Electrification requires grids, generation and storage to be expanded. It also increases demand for several minerals and technologies. Further, industrial decarbonisation requires substantial capital investment and infrastructure. The implications for competitiveness therefore depend on how energy costs, infrastructure, technological development, circularity and material security evolve together (Carrara et al., 2023; EC, 2025e; EEA, 2025h; Van Der Zwaan et al., 2025).

Moreover, electrification, efficiency, alternative production processes, renewable energy and low-carbon fuels can reduce exposure to volatility in the fossil fuel market and develop European capabilities in clean industrial technologies. However, appropriate pathways vary considerably, particularly in hard-to-abate sectors such as steel, cement and chemicals. In these sectors, the need for high-temperature heat and, in some cases, process emissions can make full direct electrification difficult. The benefits in terms of competitiveness will therefore depend on affordable clean energy, flexibility, infrastructure investment, regulatory certainty and coordination between decarbonisation, circularity and zero-pollution objectives (EEA, 2025h, 2026s).

2.2.3 Climate adaptation and resilience

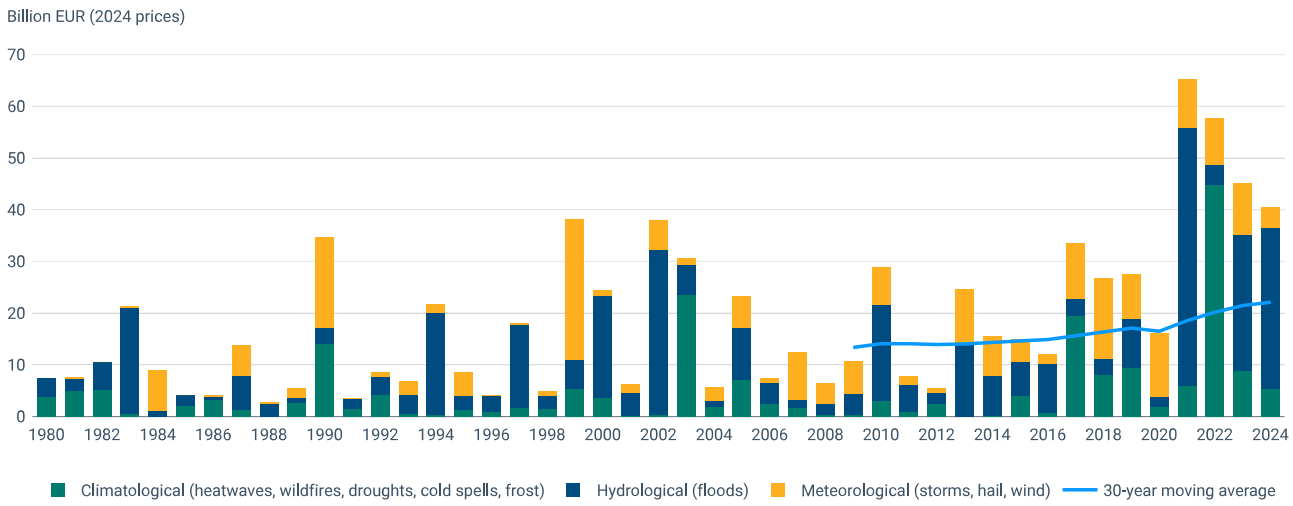
Climate and environmental change are already altering the conditions under which economic activity takes place. Although all EEA member countries have adaptation policies in place, they are currently being implemented unevenly. Gaps also persist in risk assessment, financing, monitoring, cross-border cooperation and the assignment of responsibility for managing risks (EEA, 2026e).

Extreme weather, heat stress, changing water availability and damage to infrastructure and ecosystems can reduce labour productivity, disrupt transport and production, affect agricultural yields and increase insurance, adaptation and reconstruction costs (Burke, Hsiang and Miguel, 2015; García-León et al., 2021; EEA, 2024e).

The European Climate Risk Assessment (EUCRA) identifies risks to energy and food security, ecosystems, infrastructure, water resources, financial stability and health. It indicates that several of these risks are already at critical levels and capable of cascading across systems (EEA, 2024e).

The growing economic significance of climate risks is already evident in observed losses (Figure 2.6). Weather- and climate-related extremes caused an estimated EUR 822 billion in direct losses to physical assets in the EU between 1980 and 2024. Of this total, around a quarter — EUR 208 billion — occurred in 2021-2024 alone (EEA, 2025b).

Figure 2.6 **Annual economic losses caused by weather- and climate-related extreme events in EU Member States, 1980-2024**



Source: EEA, 2025b.

Adaptation should therefore be understood as anticipatory investment in productive capacity — rather than solely as expenditure incurred in response to damage. Climate-resilient energy and transport networks, buildings, industrial sites, water systems, agricultural landscapes and digital infrastructure can reduce disruption, avoid losses and provide greater certainty for firms and investors.

EEA estimates indicate that making agriculture, energy and transport climate resilient could require around EUR 53-137 billion in annual investment up to 2050, depending on the emissions scenario. This is compared with the estimated current funding of EUR 15-16 billion per year. As a counterpoint, however, when adaptation measures are selected carefully and implemented early, they can generate economic and social benefits in addition to avoided losses, while also supporting innovation, security and competitiveness (EEA, 2026i).

Effective adaptation also depends on governance capacity and social fairness (EEA, 2025i). Climate risks and adaptive capacity differ substantially between regions and social groups. For example, smaller municipalities frequently face shortages of finance, staff, expertise and data. Adaptation measures that overlook these differences can reinforce inequalities or transfer risks between places and groups (EEA, 2026k).

In this context, climate-risk information, clear responsibilities, inclusive planning and financing arrangements that reflect who pays and who benefits are important components of economic resilience. Nature-based solutions can also complement engineered infrastructure by reducing flooding and heat while supporting biodiversity, water regulation and human well-being; however, it is necessary systematically to monitor and evaluate their effectiveness and distributional impacts (EEA, 2023d).

For Europe, this creates a potential third intersection between resilience and competitiveness. Developing and scaling technologies, services and business

models that support adaptation could strengthen domestic economic resilience while creating economic opportunities in areas such as climate-risk assessment, resilient infrastructure, water management and nature-based solutions.

Europe's regulatory and institutional experience may also support the development of standards for climate-resilient infrastructure and risk management. Adaptation should therefore be understood not only as an expenditure in response to climate change but as anticipatory investment that can protect productive assets and support innovation, security and long-term economic competitive advantage.

2.2.4 Nature protection and restoration

The fourth interconnected domain concerns the protection, restoration and responsible stewardship of natural capital. Economic activity depends on ecosystems for food and biomass, freshwater, pollination, climate regulation and protection against hazards. Biodiversity loss, pollution, soil degradation, water stress and ecosystem deterioration can therefore generate economic effects extending well beyond sectors conventionally regarded as nature-dependent (IPBES, 2019; Dasgupta, 2021; EEA, 2025a).

Pollination provides a particularly clear example. Extensive empirical research has demonstrated the contribution of wild pollinators to crop production (Garibaldi et al., 2013). More recent European modelling finds that a hypothetical collapse of wild pollination could reduce European crop yields by 8%, raise prices and alter trade. This demonstrates how the loss of an ecosystem service can propagate through economic systems (Feuerbacher et al., 2025). ECB and peer-reviewed analysis similarly identify ecosystem degradation as a potential source of risks to companies and financial institutions (Boldrini et al., 2023; Ceglar et al., 2025).

Restoring wetlands, rivers, forests, soils and urban ecosystems can simultaneously support biodiversity, water security, climate adaptation, mitigation and the preservation of human health. Nature-based solutions are therefore significant for both restoration and resilience. However, clearer assessment methods, long-term monitoring, financing and attention to the distribution of costs and benefits are needed in order to scale them effectively (EEA, 2023d).

Protecting and restoring natural capital can therefore be considered — alongside investments in physical and human capital — as a contribution to maintaining future productive capacity. Nature restoration can strengthen ecosystem function and resilience. Meanwhile, nature-positive innovation may generate new technologies, practices and business models that create economic value while reducing pressures on ecosystems (CISL, 2023).

This does not imply that all environmental measures automatically increase competitiveness or that trade-offs disappear. Rather, it means that the economic consequences of degrading or restoring natural capital should be factored into any assessment of long-term competitiveness. Land, finance, materials and institutional capacity are finite; as such, environmental transformation involves adjustment costs.

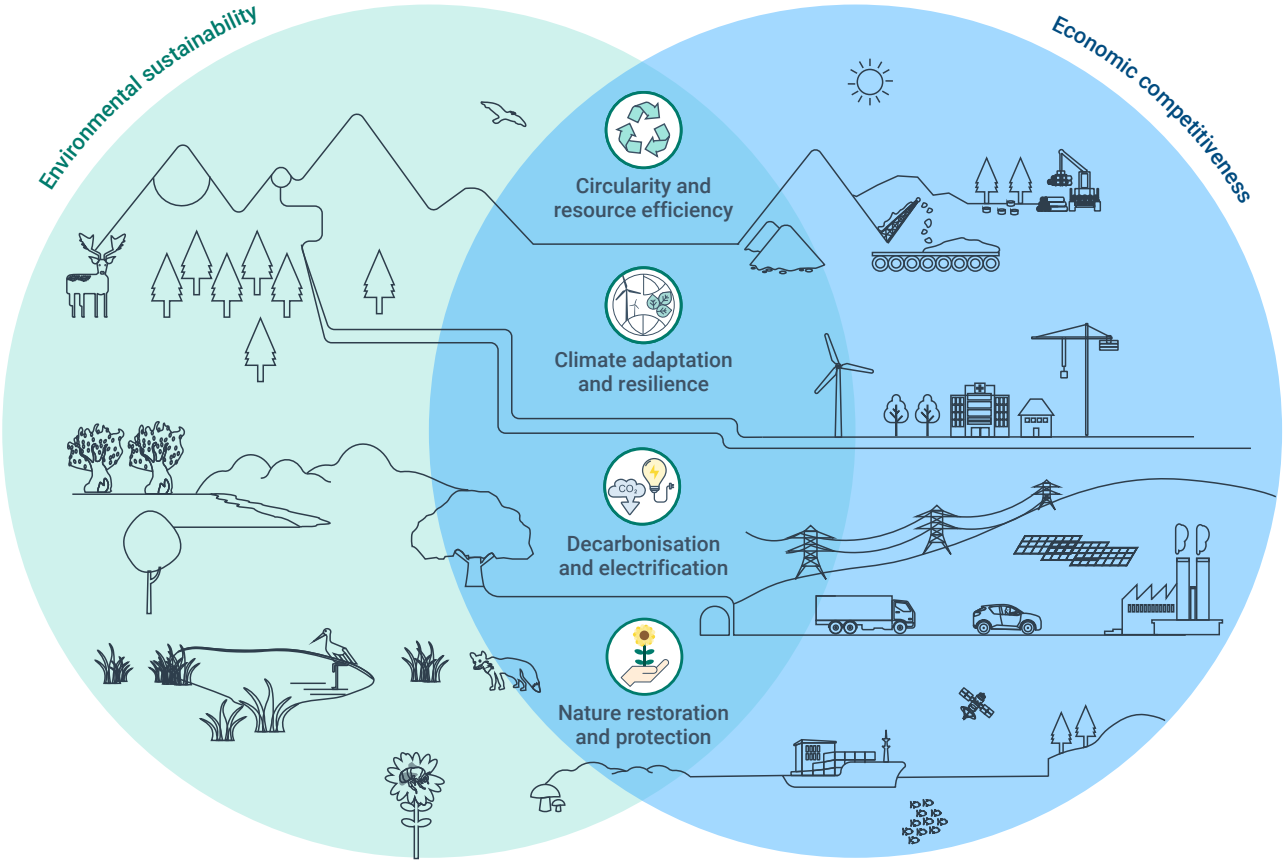
The EEA-JRC report *Zero pollution monitoring and outlook 2025* shows that pollution remains a major threat not only to ecosystems and health but also to Europe's productive capacity (EEA and JRC, 2025). A 2024 study based on EEA data estimated that air pollution costs EU Member States around EUR 600 billion annually (an amount equivalent to 4% of EU GDP). This includes losses from sickness-related absence and reduced productivity but excludes healthcare costs (Oliu-Barton and Mejino-López, 2024).

Reducing pollution should therefore be understood not only as an environmental and public-health objective but also as an investment in labour productivity, resilient ecosystems and long-term competitiveness (EEA, 2025c).

Transformation consistent with nature protection and restoration goes beyond compensating for environmental damage after it occurs. It requires investment, innovation and economic activity to be aligned with the protection and regeneration of ecosystems while recognising ecological limits and avoiding the assumption that all losses can be substituted or offset.

Figure 2.7 presents the four interconnected domains at the intersection of sustainability and competitiveness described in Section 2.2.

Figure 2.7 Four interconnected domains of long-term competitiveness



Source: EEA own elaboration.

2.3 Navigating the future — competitiveness in the context of deep uncertainty

The preceding analysis indicates how current economic performance provides only partial information about Europe's capacity to sustain prosperity over time. Conventional economic indicators may not fully reveal the deterioration of underlying natural and social assets or of declining social cohesion. Economic activity can therefore increase in the short term while some of the foundations of future productive capacity weaken (Stiglitz, Sen and Fitoussi, 2008).

Current economic performance also provides limited insight into exposure to future systemic risks. Climate change, geopolitical fragmentation, technological disruption and competition for critical resources may generate non-linear and interacting effects that cannot readily be inferred from past economic performance.

Supply-chain disruption can combine with energy and material dependencies. Meanwhile, climate hazards can affect infrastructure, financial systems and public finances simultaneously. At the same time, ecological deterioration can propagate through food systems and international value chains.

The Delphi survey conducted for this report reflects these concerns. Across selected objectives — relating to circularity, decarbonisation, resilience and nature restoration — respondents generally indicated that they thought it would be highly challenging to achieve the current EU targets and ambitions for 2040 (Kimpeler et al., 2026).

While views varied across policy areas, their responses pointed particularly to concerns about:

- implementation capacity;
- policy coherence;
- investment requirements;
- skill shortages;
- the cumulative effects of economic, environmental, technological and geopolitical uncertainty.

These findings reinforce an understanding that the challenges associated with sustaining prosperity and resilience over the longer term may be underestimated if competitiveness is assessed solely based on current economic performance.

This does not imply that established indicators of competitiveness should be replaced. Rather, it points to the value of complementing them with measures and analytical approaches that capture the resilience of the economic, environmental and social asset base on which future prosperity depends. Such a perspective can make the longer-term benefits of investment — including avoided losses, reduced dependencies and preserved productive capacity — more visible.

Strategic foresight — as employed by this report — to probe into uncertainty about the future can therefore complement conventional economic and sustainability analyses by examining how different combinations of technological, environmental, economic, geopolitical and societal developments could interact to shape Europe's long-term competitiveness.

The approach adopted in this report therefore shifts the focus from forecasting individual outcomes to understanding the conditions, interactions and uncertainties that may influence the direction of change. As such, the task of foresight is to expand the space of possibilities, reveal assumptions about how change may unfold and explore where emerging trajectories may lead under different conditions.

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3 Contextual factors shaping Europe's competitiveness to 2040

The previous chapter showed that Europe's long-term competitiveness depends not only on current economic performance but also on the environmental and social foundations that sustain it. These foundations are being reshaped by interacting contextual developments, and the direction and consequences of these remain uncertain. Looking towards 2040, this chapter examines eight contextual factors that could substantially influence the conditions for Europe's future competitiveness.

Contextual factors are broad areas of change; their future development is uncertain and they only partly sit within the influence of governments. Such factors can create risks and opportunities and guide strategic choices for policy. They provide a structured way of exploring how important developments could unfold, interact and shape the conditions for Europe's future competitiveness. As such, they serve as building blocks for the five integrated scenarios presented in the annex.

The eight factors were selected from a larger catalogue developed through expert consultation (Kimpeler et al., 2026). Selection was based on their potential significance for competitiveness and sustainability and the uncertainty surrounding their future development and impacts.

AI, for example, could raise productivity and resource efficiency but could also increase energy demand, concentrate market power and disrupt labour markets. Deeper global economic integration could expand markets and facilitate knowledge exchange while also increasing resource use and exposure to external disruptions.

3.1 Global geopolitical dynamics

Geopolitical dynamics will shape the international environment in which European competitiveness develops to 2040. Important uncertainties relate to:

- the future distribution of power;
- the global power dynamics;
- the effectiveness of multilateral institutions;
- the respective roles of both state and non-state actors.

Recent foresight analyses point to increasing geopolitical competition, the emergence of new centres of power, growing strategic dependencies and pressure on rules-based international order as important features of Europe's future operating environment (EC, 2021a; ESPAS, 2024; EC, 2025a; OECD, 2025a).

Relevance for competitiveness

Geopolitical dynamics can affect investment, trade and long-term economic planning. Political instability and conflict may disrupt markets and supply chains. At the same time, changing alliances can alter access to technologies, resources and export markets. Changes in global governance may also affect the rules governing subsidies, competition, environmental standards, taxation and intellectual property.

Consequently, Europe's competitiveness depends partly on its capacity to anticipate geopolitical risk, diversify international relationships and maintain strategic capabilities. The geopolitical context will also influence the scope for international cooperation on climate change, biodiversity loss and resource pressures.

How may this factor evolve?

One possible trajectory is a transition to an even more polarised international system organised around competing geopolitical blocs. Intensified rivalry between the United States and China could increasingly align economic relations, technologies and security arrangements with geopolitical affiliations. This would place pressure on the EU to navigate competing spheres of influence while preserving room for strategically autonomous action (EC, 2021a; ESPAS, 2024).

Alternatively, power may become more widely distributed among a growing number of influential states and regions. China could play a greater role in setting standards and organising global value chains. In this context, Europe might deepen its economic engagement with China and other emerging partners while attempting to manage concerns about resilience, security and strategic dependencies (OECD, 2025a).

A third possibility is that transatlantic and like-minded partnerships could be strengthened. Renewed cooperation between the EU, the United States, Canada, Australia and other partners could reinforce common approaches to trade, technology, security and sustainability. This could provide greater stability for European firms while strengthening the EU's position in global markets and institutions (EC, 2021a; NATO, 2022).

A more genuinely multipolar world is also plausible. India, Indonesia and several African economies may account for growing shares of global economic output, innovation and political influence by 2040. This could create new markets and partnerships for Europe while making international engagement more complex and requiring cooperation with a more diverse group of actors (OECD, 2025b).

Finally, large technology companies, digital platforms, financial networks and infrastructure providers may acquire even greater geopolitical influence. Their control over data, computing capacity, communication and technological development could challenge state-centred models of governance and require the EU to adapt its competition, regulatory and security frameworks accordingly (EC, 2021a; World Economic Forum, 2025).

3.2 International peace and security

International peace and security are dependent on the frequency, intensity and changing forms of conflict, as well as their implications for economic and societal stability. While geopolitical dynamics shape the distribution of power between states, security and peace depend on whether international relations remain predominantly cooperative or become increasingly conflictual. They can be affected by conventional military conflicts, cyberattacks, hybrid threats, economic coercion, terrorism and other forms of insecurity that can have an impact on societies, economies and critical infrastructure.

Relevance for competitiveness

Conflict and insecurity can disrupt trade routes, supply chains, energy systems and financial markets. This creates uncertainty for firms and governments and discourages long-term investment. Cyberattacks and hybrid threats can undermine critical infrastructure, digital systems and public trust. Meanwhile, geopolitical tensions may increase competition for energy, technologies and CRM.

At the same time, security-related investment can stimulate innovation and technological development. This is particularly the case in areas such as digital technologies, communications and advanced manufacturing. Europe's competitiveness will therefore depend partly on its ability to strengthen preparedness and security while maintaining the economic, environmental and social foundations of long-term resilience.

How may this factor evolve?

One uncertainty concerns the future nature of conflict. As the examples of Russia's war against Ukraine and the United States-Israel war on Iran show, both large-scale interstate warfare and hybrid forms of confrontation — including cyberattacks, disinformation, economic coercion, technological rivalry and proxy conflicts — could become more prominent and be deployed simultaneously. Such developments may create persistent uncertainty for governments and businesses, affecting supply chains, infrastructure and international cooperation (NATO, 2024; SIPRI, 2024).

The relationship between security and sustainability remains uncertain. Persistent instability can undermine investment, innovation and climate action, while peaceful and cooperative conditions can support long-term planning, technological collaboration and sustainable development. The extent to which countries can manage tensions while maintaining channels for cooperation may therefore become an increasingly important determinant of future prosperity and resilience (OECD, 2025b).

3.3 Artificial intelligence

By 2040, the expectation is that AI and deep learning will have become increasingly important drivers of change. Significant uncertainties remain regarding who will control these technologies, how they will be governed, the extent of their adoption and how their benefits and risks will be distributed.

AI applications may support scientific research, industrial automation, healthcare, public administration and the management of energy and environmental systems. However, their expansion could also disrupt labour markets, concentrate economic power and increase demand for data centres, computing infrastructure, electricity, water and CRMs.

As AI systems become more computationally intensive, the physical infrastructure supporting them may itself become an increasingly important determinant of economic competitiveness, resource demand and environmental pressures.

Relevance for competitiveness

The geographical and economic distribution of AI capabilities could become an important determinant of competitiveness. Economies that lead in AI research, computing infrastructure and deployment may gain significant advantages in terms of productivity and innovation. Conversely, reliance on external providers of semiconductors, cloud services, computing capacity and foundation models may create strategic dependencies.

Europe's position will depend not only on developing AI but also on its diffusion across firms, sectors and regions. Skills, organisational capacity, access to data, high-performance computing facilities, cloud infrastructure and data-centre capacity, together with public trust, will influence whether AI generates broad productivity gains or primarily benefits a limited number of firms.

AI may also support environmental monitoring, the optimisation of energy systems, climate-risk assessment and material efficiency. These opportunities need to be considered alongside the growing resource requirements of AI systems. The expansion of data centres and associated digital infrastructure could significantly increase demand for electricity, cooling water, land and critical raw materials. This would result in new pressures on energy systems and local environments.

Europe's competitiveness will therefore depend partly on its capacity to combine technological development with resource efficiency, resilient infrastructure, contestable markets that allow new firms and technologies to enter and challenge established players, democratic oversight and public legitimacy.

How may this factor evolve?

One key uncertainty concerns the concentration of technological capabilities and market power. AI development may become increasingly dominated by a small number of global technology firms with privileged access to advanced computing infrastructure, proprietary data, specialised skills and semiconductor supply chains. This could accelerate innovation but also concentrate economic benefits, restrict competition and increase strategic dependencies.

The location of AI infrastructure represents a related uncertainty. The growing demand for large-scale data centres, cloud-computing facilities and high-performance computing systems may create competition for electricity, water resources, grid connections and suitable sites.

Regions able to provide abundant low-carbon electricity, resilient digital infrastructure and supportive regulatory conditions may become increasingly attractive locations for AI investment. Conversely, infrastructure bottlenecks could constrain deployment and increase economic and environmental costs. Growing computational requirements could further intensify demand for energy, water and CRMs, raising questions about the sustainability and resource efficiency of large-scale AI deployment (EC, 2024c; IEA, 2024a; OECD, 2024b).

A second uncertainty concerns the effectiveness of governance. Governments may establish adaptive regulatory frameworks that support innovation while ensuring transparency, accountability, cybersecurity and ethical standards. Investments in digital infrastructure, education and reskilling could then enable wider diffusion of AI benefits.

Alternatively, governance frameworks may fail to keep pace with technological development. This would contribute to uneven adoption, labour-market disruption and growing digital inequalities (UNESCO, 2023; EC, 2024c; OECD, 2024b).

The degree of international convergence around AI governance is also uncertain. Some regions may coordinate standards and technological development, while others pursue distinct systems reflecting different political and economic priorities. Competing AI ecosystems and restrictions on data, technology and talent could increase compliance costs and weaken international research and innovation networks (EC, 2024c; OECD, 2024b; World Economic Forum, 2025).

The future role of AI in decision-making presents a further uncertainty. As AI becomes embedded in public administration, healthcare, finance, industry, security and research, accountability, human oversight and democratic control will become more significant issues. The willingness of societies to delegate critical decision-making to AI systems will depend substantially on accountability, meaningful human oversight and public trust (UNESCO, 2023)

Finally, societal acceptance of AI may vary. Some futures may involve widespread adoption of AI, while others are characterised by stronger resistance arising from concerns about surveillance, misinformation, loss of jobs and human agency. Such concerns could lead to stricter controls on deployment, particularly in sensitive domains, resulting in slower adoption and a continued preference for human-centred approaches.

For Europe, balancing technological advancement with societal values, fundamental rights and public trust is likely to remain a central challenge (UNESCO, 2023; OECD, 2024a).

3.4 Trust in public policy and regulation

Public trust in institutions, governance and regulation will influence Europe's capacity to manage structural change to 2040. Trust affects the legitimacy of public decisions, acceptance of reforms and the capacity of governments to pursue strategies whose benefits emerge over longer periods.

Recent evidence points to persistently low levels of trust in governments and political institutions, particularly in relation to governments' capacity to address complex, long-term policy challenges (OECD, 2024c). At the same time, businesses and EU policymakers have increasingly emphasised the importance of reducing regulatory complexity and ensuring clearer and more predictable rules as conditions for investment, innovation and competitiveness (EC, 2025c; European Council, 2025).

Digital technologies enable new forms of participation but also facilitate misinformation, polarisation and online harassment (Muench et al., 2024). In some contexts, there is also increasing acceptance of confrontational or disruptive approaches to political action or of non-participation in civic life (OECD, 2024c).

At the same time, citizen assemblies, local experimentation and digital participation demonstrate how governance can create opportunities for citizens to engage in democratic decision-making in a way which fosters legitimacy and accountability.

Relevance for competitiveness

Trust and social cohesion can facilitate policy coordination and the implementation of ambitious long-term strategies relating to technological transformation, sustainability and industrial development. Transparent and predictable institutions can also improve certainties around investment and reduce the costs associated with regulatory instability.

Conversely, declining trust and political fragmentation may slow decision-making, weaken policy coordination and reduce public support for necessary economic reforms. In the European context, such dynamics can affect the ability of Member States and EU institutions to act collectively on strategic challenges. In turn, this can influence the broader conditions for economic competition and long-term competitiveness.

Trust should not be understood as uncritical acceptance of public policy. Its contribution to competitiveness depends on institutional competence, transparency, accountability, fairness and meaningful opportunities for public participation. These qualities influence whether public institutions can maintain legitimacy while adapting policies to changing conditions.

How may this factor evolve?

One possible trajectory is a continued erosion of confidence in political institutions and democratic processes. Social polarisation, economic insecurity and misinformation may weaken trust in governments and experts. Governance could become more fragmented, participation may decline and policy may focus increasingly on immediate management rather than long-term development. Greater reliance on private actors and informal networks could further blur traditional responsibilities and weaken public accountability (OECD, 2024c; World Economic Forum, 2025).

Alternatively, democratic institutions may adapt through new forms of participation and deliberation. Local initiatives, citizen assemblies, digital platforms and collaborative governance could strengthen public involvement in decision-making

and increase the legitimacy of policy outcomes. Greater transparency, accountability and evidence-based policymaking may improve the legitimacy and quality of policy responses to societal challenges (EC, 2023c; OECD, 2024c).

Another uncertainty concerns the role of data and technology in governance. Data analysis and AI could enable more responsive public services, regulatory monitoring and policy evaluation. If implemented transparently and aligned with societal values, data-driven governance could strengthen confidence in public institutions.

However, this trajectory depends on citizens perceiving that data are being used ethically, securely and in the public interest. Concerns regarding surveillance, privacy, algorithmic bias or the misuse of data could equally deepen distrust if governance frameworks fail to ensure appropriate safeguards (UNESCO, 2023; OECD, 2024c).

3.5 Global trade and supply chains

Global trade and supply chains comprise the networks through which goods, services, data, capital and intellectual property move across borders. Their future development will reflect geopolitical realignment, digitalisation, environmental standards and changing patterns of production and consumption.

Technologies such as AI, advanced logistics and digital trade corridors may improve efficiency, transparency and adaptability. At the same time, data infrastructure and logistics networks are vulnerable to cyberattacks, natural hazards and geopolitical disruption. Further, new requirements relating to sustainability requirements — including carbon pricing, due diligence and circularity standards — could reshape trade and investment.

Relevance for competitiveness

Global trade and supply chains are foundational to economic growth, innovation and the delivery of goods and services worldwide. Their evolving nature presents both opportunities and uncertainties for competitiveness and sustainability. Trade supports specialisation, innovation and access to markets, resources and technologies.

More diverse markets and suppliers may expand opportunities for European firms. At the same time, digitalisation and advanced logistics could lower transaction costs. However, disruption can be transmitted rapidly through highly integrated value chains, while concentrated production creates strategic vulnerabilities.

Regionalisation and protectionism may improve some forms of security but increase production costs, reduce market access and slow knowledge exchange. Sustainability standards may support innovation and reduce environmental pressures. However, conversely, divergent regulatory approaches can increase compliance costs and generate trade disputes. Europe's competitiveness will depend on balancing openness and efficiency with resilience, strategic capacity and environmental integrity.

How may this factor evolve?

One key uncertainty concerns the future degree of globalisation versus regionalisation. In one possible trajectory, geopolitical tensions, supply chain vulnerabilities and security concerns would encourage countries and regions to reduce their dependence on distant suppliers and strengthen regional production networks.

Trade would become increasingly organised around regional blocs and shorter supply chains, supported by new institutions and cooperation mechanisms. While such a shift may improve resilience and reduce exposure to global disruptions, it could also alter patterns of global economic integration, affect development opportunities across regions and create new pressures on regional resource use and land systems (WTO, 2024).

A second uncertainty relates to the persistence and expansion of global economic integration. Advances in digital connectivity, logistics, trade facilitation and international cooperation may reinforce globalisation. This would lead to an increasingly interconnected global marketplace. In this future, barriers to trade are reduced, cross-border investment expands and global value chains become more deeply integrated. Such developments could generate significant economic efficiencies, accelerate innovation and increase consumer access to goods and services.

At the same time, greater interconnectedness may also increase exposure to global shocks, environmental pressures and resource consumption associated with expanding production and consumption patterns.

Another uncertainty concerns the future distribution of economic influence within global trade systems. China may further consolidate its role as a central hub in international trade, logistics, manufacturing and critical resource supply chains. Through its scale, infrastructure investments, technological capabilities and control over strategic production networks, China could become increasingly indispensable to the functioning of the global economy.

While other economies may seek to diversify suppliers and reduce their strategic dependencies, the complexity and cost of restructuring supply chains may limit the pace of change. For Europe, this raises important questions regarding economic resilience, strategic autonomy and the balance between economic efficiency and supply security (UNCTAD, 2024).

A further uncertainty relates to the resilience of the institutions that underpin global trade. International trade currently relies on a complex architecture of rules, agreements, governance mechanisms and political stability. However, prolonged geopolitical instability, declining institutional effectiveness or broader governance crises could weaken the ability of states and international organisations to coordinate economic activity.

In such a future, formal governance structures may become less influential, while decentralised networks, private actors and alternative coordination mechanisms assume greater roles in maintaining economic exchange. Although trade and economic activity may continue, they could become more fragmented, less predictable and increasingly dependent on informal arrangements and non-state actors (ESPAS, 2024; OECD, 2025a).

The relationships between trade, resilience and sustainability also remain uncertain. Efforts to strengthen supply chain security, reduce strategic dependencies and accelerate the green transition may reshape trade flows and investment patterns. At the same time, growing demand for CRMs, low-carbon technologies and digital infrastructure could create new dependencies and intensify competition for resources.

The extent to which future trade systems can balance efficiency, resilience, sustainability and geopolitical considerations will significantly influence Europe's long-term competitiveness (WTO, 2024).

3.6 The availability of critical raw materials

Current developments highlight the intensifying global competition for CRMs. This is likely to remain a significant feature of change to 2040. Major economies are seeking to secure long-term access to key materials such as lithium, cobalt and nickel; these are essential for batteries and clean energy technologies.

Strategic partnerships between resource-rich and industrialised countries are becoming more prominent. Meanwhile, export restrictions on certain CRMs are increasing. At the same time, geopolitical rivalries — particularly between major powers — are influencing resource strategies, with countries seeking to diversify supply chains and reduce their reliance on dominant suppliers.

A prominent example is the EU's effort to diversify supplies of CRMs and rare earth elements. This is due to the fact that high dependence on Chinese extraction and processing capacity has been identified as a strategic vulnerability for both industrial competitiveness and economic security.

Regions such as Africa are also gaining importance as sources of critical raw materials. Meanwhile, tensions related to mining activities and their social and environmental impacts are becoming more visible.

Relevance for competitiveness

Raw materials are indispensable for emerging technologies associated with the green and digital transitions, including renewable energy systems, electrolysers, batteries and advanced manufacturing processes. Scarcity or supply disruptions could therefore become major bottlenecks for industrial development and sustainability transitions.

Demand for CRMs is expected to increase substantially as the EU expands renewable energy, electrification and digital technologies. The EC estimates that EU demand for lithium could increase 12-fold by 2030 and 21-fold by 2050. Meanwhile, demand for rare earth elements could increase six-fold by 2030 and seven-fold by 2050 (Carrara et al., 2023).

Earlier EC foresight analysis, based on a high-demand scenario, estimated that lithium demand could reach almost 60 times current EU consumption by 2050 (EC, 2020b; Carrara et al., 2023).

How may this factor evolve?

One key uncertainty concerns the future balance between global demand and supply. In the face of growing demand for CRMs, supply chains may face increasing pressure from slower resource development, environmental constraints, geopolitical tensions and concentrated production in a limited number of countries — even though global reserves remain significant. Under such conditions, competition for access to strategic resources could intensify, leading to higher prices and increased market volatility (IEA, 2024b).

A second uncertainty relates to Europe's continued dependence on imported raw materials. In one possible trajectory, Europe remains highly reliant on external suppliers but succeeds in maintaining relatively secure access through diversification strategies, strategic partnerships, stockpiling mechanisms and investments in domestic extraction and processing capacities. Such measures could strengthen resilience against disruptions even if global competition increases and costs continue to rise.

However, Europe's competitiveness would remain vulnerable to developments beyond its direct control. These would include geopolitical tensions and export restrictions imposed by major producer countries.

Another uncertainty concerns the effectiveness of innovation in reducing material dependency. Advances in recycling technologies, circular economy practices, material substitution, resource efficiency and new production processes may significantly reduce Europe's exposure to raw material constraints, though it must be recognised that there will always be some losses and leakages from the system and that 100% circularity is not possible.

In this future, innovation would enable the economy to extract greater value from existing resources while reducing reliance on imported primary materials. Although some strategic dependencies may persist, technological progress and circularity could strengthen resilience and mitigate the economic impacts of growing global scarcity (EC, 2024c).

A further uncertainty relates to the extent to which adaptation can offset increasingly constrained global availability. Even where Europe successfully expands recycling, reuse and resource efficiency measures, certain industries may remain dependent on imported critical materials that are difficult to substitute.

In a context of severe global scarcity, supply disruptions, geopolitical instability and resource nationalism could continue to expose strategic sectors — including clean technologies, semiconductors, defence and advanced manufacturing — to significant risks. Europe's ability to reduce its vulnerability may therefore vary across sectors and materials (IEA, 2024b).

Finally, there is uncertainty regarding the possibility of more systemic resource constraints. Accelerated depletion of accessible resources, combined with environmental degradation, geopolitical conflict and insufficient investment in alternative supply sources, could create widespread shortages that affect multiple regions simultaneously. In such a future, adaptation efforts may be insufficient to prevent cascading disruptions across industrial systems, trade networks, energy transitions and broader economic activity.

While such an outcome is generally considered less likely, it would have profound implications for Europe's economy, social stability and prospects for long-term development (UNEP IRP, 2024).

3.7 Vulnerability and adaptation to climate and environmental change

Vulnerability to climate change is the degree to which the economy and society are susceptible to harm from climate-related hazards such as heatwaves, droughts, floods and storms. It reflects both exposure to climate impacts and the capacity to adapt or cope with these changes.

Furthermore, it is necessary to consider regional disparities in vulnerability — with southern Europe facing higher risks of drought and wildfires and northern Europe more prone to flooding. In addition, the interaction between climate change, biodiversity and economic activity could create new forms of compound vulnerability.

Water provides a useful example. Increasing drought and heat can reduce water availability for agriculture, energy generation and industrial production. At the same time, land sealing, the degradation of soils, forests, wetlands and other ecosystems can reduce their capacity to retain water, regulate floods and provide other services that support economic activity.

The result is that a climate shock affecting one sector can propagate across several others. This potentially affects food production, energy security, industrial output and regional economies.

The EEA identifies water, agriculture, forestry and biodiversity as strongly interdependent. Meanwhile, the EUCRA identifies 36 major climate risks spanning ecosystems, food, infrastructure, energy, water, the economy and finance (EEA, 2024e).

This suggests that future vulnerabilities may increasingly depend not only on exposure to individual hazards but also on the resilience of the connections between economic, environmental and infrastructure systems. Moreover, social and demographic factors — including age, income and health status — affect people's ability to cope with climate stress (Quante et al., 2024).

Relevance for competitiveness

Climate vulnerability can affect competitiveness through physical damage, supply-chain disruption, lower labour productivity and higher insurance, financing and public expenditure. Repeated climate-related events may also divert investment from innovation and productive activity towards recovery and reconstruction.

The distribution of impacts can deepen regional and social inequalities. Regions with high exposure and limited adaptive capacity may become less attractive for investment and face increasing pressure on public services and infrastructure.

Adaptation can reduce some of these risks while creating opportunities in water management, resilient construction, agriculture and nature-based solutions. However, adaptation requires substantial investment and cannot eliminate every risk.

Europe's competitive advantage will depend partly on its capacity to tackle all the challenges together by reducing exposure, strengthening adaptive capacity and addressing environmental and social vulnerabilities.

How may this factor evolve?

One key uncertainty concerns the effectiveness of adaptation efforts in reducing climate vulnerability. In one possible trajectory, Europe successfully develops robust adaptation systems that combine technological innovation, resilient infrastructure, effective governance and social preparedness.

In this scenario, despite increasingly severe climate hazards, coordinated adaptation measures would enable societies, economies and ecosystems to absorb and recover from shocks. Investments in climate-resilient infrastructure, nature-based solutions, disaster risk management and adaptive governance would help to limit the most severe impacts. This would allow Europe to maintain relatively high levels of resilience even in a more hazardous climate (EEA, 2024e).

A second uncertainty relates to the capacity of institutions and societies to respond to escalating environmental pressures. Climate impacts may intensify faster than adaptation measures can be implemented. This would lead to cascading effects across ecosystems, public health, food systems, infrastructure and economic activities.

In this future, weak governance, insufficient investment, technological limitations and growing social inequalities would undermine adaptive capacity. Vulnerable populations and regions may experience disproportionate impacts. Meanwhile, repeated crises would strain public institutions and social cohesion (IPCC, 2023; UNEP, 2024)

Another uncertainty concerns Europe's relative position within a global landscape where adaptation is uneven. Europe may succeed in strengthening its resilience through proactive policies, strong institutions and sustained investments in adaptation, while many other regions face greater difficulties coping with climate impacts.

In such a future, Europe would experience comparatively lower levels of vulnerability, benefiting from resilient infrastructure, effective governance and social protection systems. However, climate risks would remain interconnected globally. Disruptions to trade, migration pressures, food security challenges and geopolitical instability originating elsewhere could continue to affect Europe despite its stronger domestic adaptive capacity (IPCC, 2023).

A further uncertainty relates to the role of emerging technologies in supporting adaptation. Advances in AI, digital twins, predictive analytics, remote sensing and automated response systems may enhance Europe's ability to anticipate and manage climate risks [(3)]. AI-enabled forecasting systems could improve early warning capabilities, optimise resource allocation and support rapid local responses to extreme weather events.

In this future, technological intelligence would compensate for some limitations in human adaptive capacity, strengthening the resilience of critical infrastructure and public services. However, the effectiveness of such systems would depend on data quality, governance arrangements, accessibility and public trust in technology-driven decision-making (OECD, 2024a; WMO, 2024).

(3) Digital twins are virtual representations of physical assets, systems or environments that use real-world data to simulate their behaviour and conditions.

Finally, there is uncertainty regarding major environmental and climate tipping points. Accelerating climate change could trigger large-scale and potentially irreversible shifts in ecological and Earth-system processes. The outcomes could include biodiversity collapse, ecosystem degradation, changes in ocean circulation or widespread water and food insecurity. In such circumstances, adaptation measures may become increasingly ineffective as the scale and pace of change exceed societal and institutional capacities to respond.

Cascading impacts across environmental, economic and social systems could create systemic disruptions that no region, including Europe, would be able to avoid fully (IPCC, 2023; EEA, 2024e).

3.8 Electrification and future energy systems

Electrification is expected to play a central role in decarbonising transport, industry, buildings and energy systems. It is also expected to increase demand for reliable, affordable and sustainable electricity. Important uncertainties concern the pace of electrification, the organisation of energy systems and the balance between domestic production, international trade, affordability and resilience.

The future configuration of Europe's energy system will depend on investment in generation, grids, storage, flexibility and digital infrastructure. It will also be shaped by material availability, public acceptance, market design and coordination across Member States (EEA, 2025h).

Relevance for competitiveness

A successful transition to an electrified energy system could reduce Europe's dependence on imported fossil fuels, enable cleaner industrial production and support innovation in energy technologies and services. Greater efficiency may lower operating costs and reduce pressure on generation and grid infrastructure.

Conversely, high electricity prices, inadequate grid capacity and poorly coordinated investment could weaken industrial competitiveness. Digitalisation may improve system management but also create cybersecurity risks. Meanwhile, greater dependence on critical materials and imported technologies may introduce new strategic vulnerabilities.

Europe's future competitiveness will therefore depend not only on the amount of low-carbon electricity available but also on it is affordable and whether systems are integrated and reliable. The distribution of costs and benefits across households, industries and regions will also influence the legitimacy and pace of the transition.

How may this factor evolve?

One key uncertainty concerns the degree of coordination and integration within Europe's energy system. In one possible trajectory, European countries would pursue divergent electrification strategies based on national priorities, resource availability, political preferences and industrial interests. While electricity demand would increase as fossil fuels are phased out, the absence of a strongly coordinated European approach would result in uneven progress, fragmented infrastructure development and limited cross-border energy exchange. Such a landscape may create regional disparities in energy prices, industrial competitiveness and access to clean energy.

Another uncertainty concerns Europe's approach to energy sourcing and external dependencies. Electricity demand is expected to increase substantially as electrification expands across sectors. In one possible trajectory, Europe would meet growing demand through a diverse and flexible mix of domestic and imported energy sources. These could include renewable electricity, hydrogen and other energy carriers.

However, without coordinated strategic planning, this could result in a reactive and market-driven energy system characterised by price volatility, supply uncertainty and continued exposure to global energy markets. Complex international supply chains and geopolitical developments could create additional vulnerabilities, particularly for energy-intensive industries.

A further uncertainty concerns the emergence of global renewable energy hubs. Europe may increasingly rely on large-scale renewable energy production in regions with favourable natural conditions. These could include areas with abundant potential for solar, wind or hydropower. Electricity imports, renewable hydrogen and other energy carriers from international partners could support Europe's decarbonisation objectives and reduce pressure on domestic resources.

At the same time, this trajectory would create new forms of strategic dependency, requiring long-term partnerships, investment in infrastructure such as grids and pipelines as well as robust governance arrangements to ensure energy security, sustainability and geopolitical stability.

The relationship between electrification and competitiveness also remains uncertain. A successful transition towards an integrated, affordable and resilient electricity system could strengthen Europe's industrial position by enabling clean production, reducing fossil fuel dependencies and supporting new technologies.

Conversely, fragmented approaches, insufficient investment in infrastructure or persistent exposure to volatile global energy markets could increase costs for European industries. They could also create competitive disadvantages compared with regions with lower energy costs or greater resource availability.

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4 'No-regret options' for Europe's sustainable competitiveness towards 2040

This chapter presents the main outcomes of the foresight exercise introduced in Section 1.3, which aimed to explore how the conditions for Europe's competitiveness and sustainability could develop towards 2040. This chapter identifies strategic options that Europe could consider pursuing in a changing context and that are likely to involve no regrets.

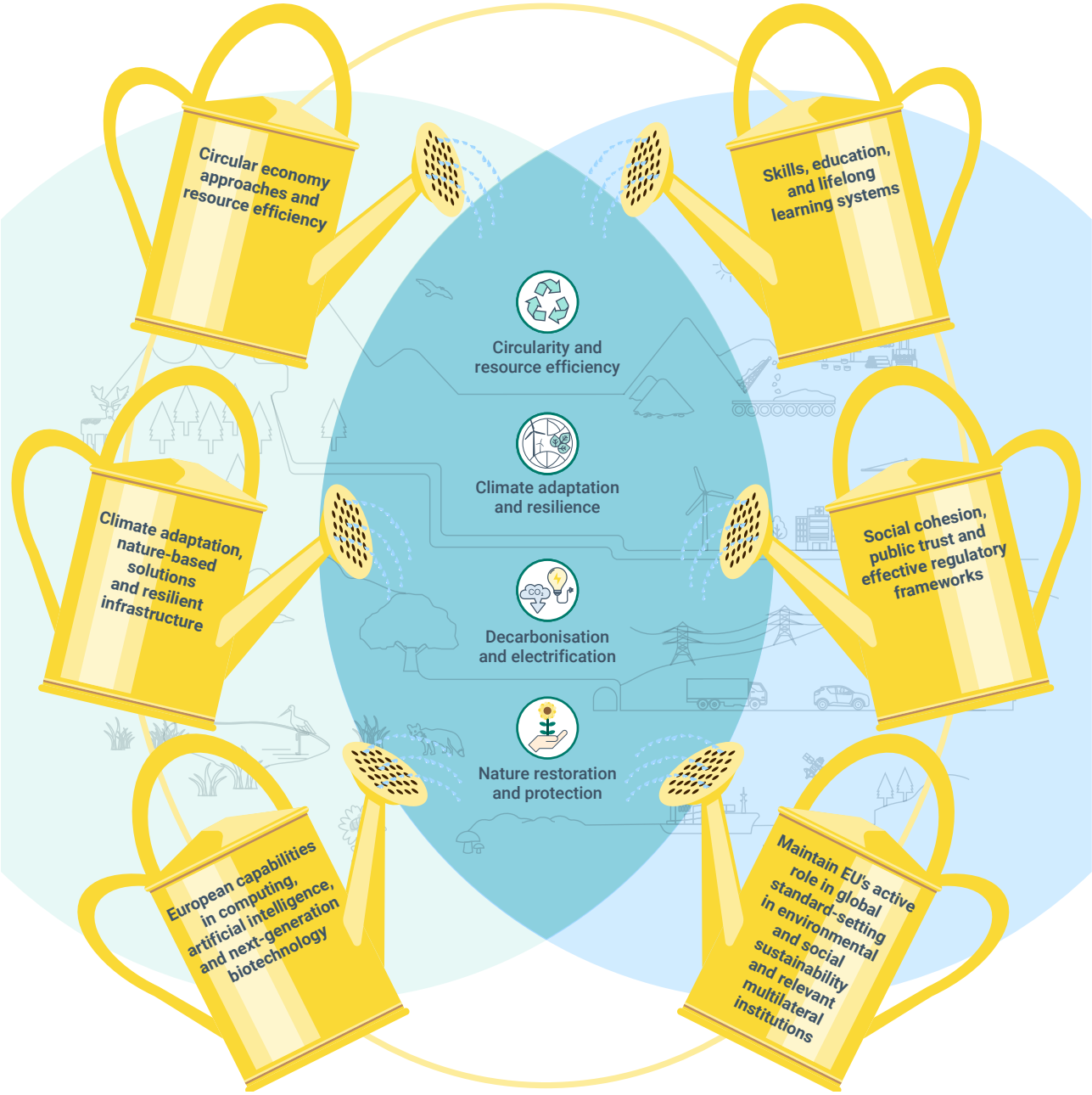
As explained in detail in the methodology (Section 1.3), the contextual factors and their possible trajectories identified in Chapter 3 were used as a basis for developing five plausible future scenarios (see Annex 1). The aim of the scenarios was to explore how Europe's strategic position could be affected by geopolitical, technological, economic, environmental and societal developments under different future conditions.

The analysis of opportunities and tensions within and across scenarios was undertaken by experts. It led to the identification of no-regret options. These are intended as robust strategic directions that could strengthen Europe's resilience, adaptability and preparedness despite uncertainty about how the future will develop.

This chapter discusses the following six no-regret options (see Figure 4.1):

- scaling up circular economy approaches and resource efficiency to reduce material and energy dependencies and strengthen energy security and resilience to supply disruptions;
- investing in climate adaptation, nature-based solutions and resilient infrastructure to reduce vulnerability and protect productive capacity and essential services;
- developing European capabilities in computing, AI and next-generation biotechnology to support innovation and reduce strategic technological dependencies;
- strengthening skills, education and lifelong learning to support adaptation to technological, environmental and structural change;
- supporting social cohesion, public trust and effective regulatory frameworks to strengthen implementation, innovation capacity and societal resilience;
- maintaining an active EU role in international standard-setting and multilateral institutions to shape international rules, diversify relationships and preserve channels for cooperation.

Figure 4.1 The six no-regret options for long-term competitiveness



Source: EEA own elaboration.

Each no-regret option is analysed from two perspectives. First, the potential contribution to sustainable competitiveness of each no-regret option is discussed in the context of the four domains identified in Chapter 2: circularity and resource efficiency; decarbonisation and electrification; climate adaptation and resilience; and nature restoration and a nature-positive economic transformation.

The EU has already established strategies, legislation and investment frameworks pointing in many of the same directions as the no-regret options. As such, the second part of the analysis summarises the principal relevant EU strategies and measures for each option.

The options reflect the collective judgements of the participating experts about potentially important directions for Europe towards 2040. They are not predictions that particular measures will produce specific outcomes nor are they intended to replace detailed policy appraisal.

Statements about their possible contributions should therefore be understood as expert-informed propositions derived from the scenario exercise rather than claims about outcomes that can be established in advance. References are included where the analysis draws on published research, observed trends or evidence about present-day conditions.

4.1 Six no-regret options across the 2040 scenarios

4.1.1 Circular economy approaches and resource efficiency

Scaling up the circular economy and resource efficiency could strengthen sustainable competitiveness towards 2040 under a wide range of future conditions. Demand for primary resources and the energy required for their extraction, processing and manufacture could be reduced by:

- extending product lifetimes;
- using products and infrastructure more intensively;
- retaining the value of materials and components by keeping products in use through repair, reuse, refurbishment and recycling.

This could lower production costs and GHG emissions. By lowering overall energy demand and retaining the energy embodied in products, materials and infrastructure, circular approaches could also reduce the scale of additional energy-system capacity required (EEA, 2024c, 2025c, 2026b).

Circularity could also strengthen energy security and contribute to resilience by reducing exposure to disruptions from the volatile energy and commodity markets characteristic of global supply chains. Further, it could make economies less dependent on continuous access to imported energy and raw materials.

This may become increasingly important as climate change increases the frequency and intensity of disruptions to energy, water, transport and industrial infrastructure. This is in a context in which extreme weather events can simultaneously affect domestic production and international supply chains.

Circularity can therefore be understood as more than just a strategy for reducing environmental pressures. It can also be a means of increasing the capacity of economies to absorb and recover from climate-related, geopolitical and supply-side shocks.

Circularity and resource efficiency

Across the scenarios, the greatest potential in this area came from moving beyond an emphasis on recycling and waste management towards reducing resource and energy demand throughout entire product and infrastructure life cycles.

Products could increasingly be designed for durability and so that they can be repaired, upgraded, reused and disassembled. Meanwhile, business models based on

maintenance, sharing, product-as-a-service and remanufacturing could help retain the economic value, materials and energy embodied in them.

More intensive and efficient use of existing buildings, machinery and infrastructure could similarly reduce the need for new construction, extraction of primary materials and additional energy consumption. This would limit exposure to energy-price volatility and pressure on energy supplies (EEA, 2023a, 2026j).

Developing these approaches at scale could reduce demand for secondary raw materials and reduce exposure to some supply disruptions. However, recycling alone would not eliminate dependence on primary resources. This is particularly the case where demand is growing rapidly or materials are dispersed, contaminated or technically difficult to recover.

EEA assessments also indicate that increasing recycling alone will be insufficient to achieve a circular economy without simultaneously reducing material demand and extending product lifetimes (EEA, 2024f, 2025c).

The scenarios point to the importance of combining circular supply with resource and energy efficiency, waste prevention and measures addressing overall demand. By reducing the energy required to extract, process and manufacture materials, this combination of approaches could complement efforts to diversify energy supplies and strengthen resilience to energy-market disruptions. Its benefits would nevertheless depend on avoiding rebound effects in which lower costs or efficiency gains result in higher consumption (EEA, 2023b).

Decarbonisation and electrification

Circularity and resource efficiency are central concepts for decarbonisation; they could reduce GHG emissions and energy demand across industrial value chains. More efficient use of steel, cement, aluminium, plastics and other energy-intensive materials could lower the energy and emissions embodied in European production. Further, repair, reuse and remanufacturing often retain more of the energy and economic value embedded in products than recycling them into raw materials.

Circularity could therefore complement increased use of renewable energy, electrification and improvements in energy efficiency by reducing the number of grids and amount of clean-energy generation, storage and industrial capacity required to meet a given level of societal need.

Lower and more flexible energy demand could also strengthen energy security by reducing dependence on imported fuels. This would limit exposure to price volatility and ease pressure on energy systems during periods of disruption (EEA, 2024c, 2025h, 2026l, 2026s).

Circular approaches could also support decarbonisation and electrification in the area of industrial transformation in Europe by creating markets and capabilities in maintenance, remanufacturing, materials recovery and low-carbon manufacturing. Designing renewable-energy technologies, batteries, electricity-grid components and electric vehicles for durability, repair, repurposing and high-quality recovery could reduce demand for energy-intensive primary production, improve access to strategically important materials and strengthen the resilience of Europe's energy transition (EEA, 2025h, 2026j).

These measures would complement rather than substitute investment in renewable energy, grids, storage and low-carbon industrial processes. Circular systems

themselves require energy and infrastructure and will deliver the greatest mitigation and energy-security benefits when powered by an increasingly decarbonised and resilient energy system (EEA, 2025h, 2026b).

Climate adaptation and resilience

Resilience could be strengthened through circularity, material efficiency and energy efficiency since these approaches would reduce Europe's exposure to disruptions in international supplies of fuels, materials and components. Improved use of materials already present in Europe's buildings, infrastructure, machinery and products could provide more diversified and geographically distributed sources of supply.

EEA analysis indicates that accumulated material stocks could become an increasingly important source of secondary materials within Europe; however, their recovery depends on better information, suitable design and economically viable recovery systems (EEA, 2026j). Repairable and modular equipment could also allow essential energy, water, transport and communications systems to be restored or adapted more rapidly following climate-related disruption.

However, while the scenarios show that circularity is central to resilience, it must also be aligned with adaptation objectives. Extending the lifetime of energy-inefficient buildings or assets highly exposed to flooding, heat or water scarcity could lock in vulnerability and emissions rather than reduce them.

Circular strategies focused on this aim would therefore need to account for future climate conditions and whole-life energy performance. They would need to recognise that some assets should be renovated and adapted while others may need to be fundamentally redesigned, relocated or retired. This reflects the broader need to avoid maladaptation and ensure that infrastructure and investment decisions remain robust under changing climate conditions (EEA, 2024e).

Nature restoration and protection

Reducing demand for primary materials and energy could lessen the pressures associated with mining, quarrying, fossil-fuel extraction, forestry, biomass production and land conversion. Circular management of nutrients, water, construction materials and biological resources could also reduce pollution and help limit the pressures on soils, rivers and ecosystems.

By lowering the material and energy requirements of production and consumption, circularity could allow greater scope for restoring ecosystems while reducing Europe's environmental and carbon footprints beyond its borders.

These contributions would depend on strong environmental safeguards. Greater use of biomass, for example, is not necessarily circular, low-carbon or sustainable if it drives land-use change, overharvesting or competition with ecosystem restoration. EEA analysis of the bioeconomy emphasises that responsible sourcing, biodiversity safeguards and attention to land-use impacts are essential if bio-based innovation is to contribute to sustainability (EEA, 2025g).

Similarly, energy-intensive or low-quality recycling may offer limited environmental benefits. Meanwhile, recycling that retains hazardous substances could shift rather than resolve pollution pressures.

A nature-positive circular economy would therefore need to prioritise reduced demand, renewable energy, non-toxic material cycles, sustainable sourcing and the preservation of ecological functions alongside material recovery (EEA, 2024b, 2026b).

Box 4.1

Current EU action supporting circularity and resource efficiency

The EU already has an extensive policy structure supporting the transition towards a more circular and resource-efficient economy. The 2020 circular economy action plan provides the overarching framework, covering the full product life cycle from design and production to consumption, repair, reuse and waste management. It prioritises resource-intensive value chains — including for electronics, batteries, vehicles, packaging, plastics, textiles, construction and food. It also seeks to reduce the EU's consumption footprint while increasing the use of secondary materials.

Product policy is increasingly being used to address circularity upstream. The Ecodesign for Sustainable Products Regulation sets out requirements concerning product durability, reliability, repairability, upgradability, recycled content, resource- and energy efficiency and wider environmental performance. It introduces a digital product passport. The intention is to improve access to information on product composition and performance across value chains, supporting maintenance, repair and high-quality material recovery.

The Directive on Common Rules Promoting the Repair of Goods complements this framework by seeking to make repair more accessible and attractive to consumers and to strengthen demand for repair services.

Several sector-specific measures are also shaping circular value chains. The Batteries Regulation introduces requirements relating to the carbon footprints, recycled content, durability, and recovery of materials.

The Packaging and Packaging Waste Regulation includes measures on packaging prevention, reuse, recyclability and recycled content. EU rules and strategies concerning textiles, construction products, waste electrical and electronic equipment and single-use plastics similarly seek to prevent waste and retain the value of products and materials for longer. Circularity is also becoming more closely connected to climate, energy and industrial policy. The Clean Industrial Deal identifies circularity as a means of supporting industrial decarbonisation, reducing energy and material costs and strengthening economic security. It establishes an ambition for circular materials to account for 24% of EU material use by 2030.

By reducing demand for energy-intensive primary production and supporting markets for recycled materials, its circular-economy component could complement electrification, the deployment of renewable energy and the decarbonisation of energy-intensive industries.

The Critical Raw Materials Act further connects circularity with strategic autonomy. It establishes a benchmark under which EU recycling capacity should be able to produce at least 25% of the EU's annual consumption of strategic raw materials by 2030. It also promotes waste prevention, reuse and the recovery of critical materials from products, waste streams and extractive waste. These measures recognise that recycling cannot eliminate the need for primary supply but could diversify sources and reduce some external dependencies.

The forthcoming Circular Economy Act — scheduled for adoption in 2026 — is intended to strengthen the single market for waste and secondary raw materials, increase the supply of high-quality recycled materials and stimulate demand for them within the EU. It is expected to address the regulatory and market fragmentation that currently limits the movement and uptake of secondary materials. Its effectiveness will depend on its interaction with product standards, chemicals and waste legislation, industrial policy and implementation in the Member States.

4.1.2 Climate adaptation, nature-based solutions and resilient infrastructure

Experts identified investment in climate adaptation and resilient infrastructure as a measure that could help protect Europe's productive capacity across a wide range of futures. Strengthening climate resilience can help safeguard Europe's prosperity and competitiveness by:

- reducing exposure to physical climate risks;
- limiting disruption to critical infrastructure and supply chains;
- protecting the productive capacity of regions and businesses.

Energy, transport, water, digital and urban infrastructure will continue to provide essential services to firms, households and public institutions. Strengthening these systems against floods, droughts, heatwaves, wildfires and other disruptions could reduce physical damage, limit interruptions to economic activity and lower future reconstruction costs.

However, the benefits could further extend beyond individual assets. Because infrastructure systems are highly interconnected, disruption to energy or digital networks could affect transport, industry, healthcare and water services. Adaptation that takes these interdependencies into account could reduce the risk of impacts cascading across sectors and regions. This could be particularly important in fragmented or conflictual futures, where access to external assistance, finance or replacement components might be constrained (EEA, 2024e; Lentini, Eklund and Corbane, 2025).

Resilient infrastructure in Europe could also include natural systems. Restoring wetlands, forests, soils and urban ecosystems could contribute to water retention, flood protection, cooling, erosion control and reduced risk of wildfire. Healthy ecosystems provide a wide range of services that underpin economic activity, including water regulation, soil fertility, carbon sequestration, flood protection, pollination and climate resilience.

Nature-based solutions can therefore deliver multiple benefits simultaneously; they can support climate adaptation, the conservation of biodiversity, human well-being and economic resilience. As climate impacts intensify, maintaining and restoring these ecosystem functions becomes increasingly important for reducing economic vulnerabilities and protecting critical infrastructure, supply chains and productive sectors (Feyen et al., 2020; EEA, 2021).

Circularity and resource efficiency

Climate adaptation and resilient infrastructure can work in tandem with circular and resource-efficient economy measures. This is particularly evident in the area of water management. Here, reducing abstraction, increasing water-use efficiency and reuse, improving water retention and restoring ecosystems can simultaneously reduce exposure to drought and water scarcity and ensure more efficient use of the resources which are available.

Greater circularity in water use and ecosystem restoration is key to strengthening water resilience. Meanwhile, safe and sustainable water reuse holds potential for protecting ecosystems, reducing pressures on freshwater resources and strengthening circular water management (Arrigoni, Mitev and Vazquez, 2026; Pistocchi et al., 2026).

More broadly, designing infrastructure to remain functional under changing climatic conditions could help to avoid repeated damage, reconstruction and premature replacement of assets. This, in turn, could reduce the associated demand for materials and resources. In this sense, resilience and circularity can be mutually reinforcing where adaptation strategies emphasise efficient resource use, longer-lived assets and reduced dependence on primary resources.

Decarbonisation and electrification

The transition towards electrified and increasingly digital production, hydrogen-based processes, carbon management and other low-carbon technologies will increase industry's dependence on reliable electricity grids, water supplies, transport networks and other enabling infrastructure. Climate-related disruption to these systems could interrupt production, constrain access to energy and water as well as increasing the costs and risks associated with long-lived industrial investments.

Building climate resilience into new energy and industrial infrastructure from the outset can therefore help to safeguard decarbonisation investments and ensure that low-carbon industrial systems remain reliable under changing climatic conditions (Tavares Da Costa, Krausmann and Hadjisavvas, 2023; EEA, 2024e; Coffano *et al.*, 2026).

Adaptation can also generate direct mitigation co-benefits, particularly where resilient infrastructure is combined with nature-based solutions and circular resource strategies. Urban green infrastructure, for example, can reduce exposure to extreme heat while also lowering energy demand for cooling and increasing carbon sequestration. Equally, restoring forests, wetlands and other ecosystems can simultaneously strengthen climate resilience and maintain or increase natural carbon stocks (Quaranta, Dorati and Pistocchi, 2021; EEA, 2023d, 2023e, 2024d).

Circular strategies can reinforce these benefits by reducing demand for energy- and carbon-intensive primary materials. JRC analysis suggests that ambitious material reduction, reuse and recovery strategies in selected energy-intensive industries could substantially decrease GHG emissions beyond technology-based decarbonisation alone (Walker. et al., 2025).

Integrating resilience, circularity and decarbonisation into infrastructure and industrial planning could therefore help to avoid investments that are currently low carbon but would be vulnerable or resource-intensive under future conditions. For example, locating hydrogen or industrial facilities in areas likely to face increasing water scarcity could create future constraints, while renewable energy infrastructure designed without consideration of material recovery and recycling could increase dependence on virgin raw materials.

Climate adaptation and resilience

Climate adaptation is also increasingly understood both as an economic necessity and an investment priority. Integrating resilience into long-term planning and investment decisions can therefore help to avoid future damage, reduce disruption and limit the costs of adapting infrastructure retrospectively.

Climate-related extremes are already generating substantial economic losses across Europe. At the same time, the risks to infrastructure, productivity, supply chains, public finances and financial stability are increasing (Feyen *et al.*, 2020; EEA, 2024e, 2025b).

In this context, climate adaptation could also create opportunities for innovation and economic activity. European expertise in water management, climate services, early-warning systems, resilient construction, urban cooling and climate-smart agriculture might become increasingly valuable as climate pressures intensify globally. Such capabilities could help protect domestic assets while creating exportable knowledge and services.

Recent EEA assessments highlight that while adaptation planning has advanced significantly across Europe, progress in implementing it remains uneven. There are persistent gaps in financing, monitoring, institutional capacity and coordination across governance levels.

Increasingly it is recognised that strengthening these enabling conditions is as important as developing adaptation strategies themselves. Effective adaptation will require not only technical solutions but also the capacity to translate risk assessments into action, monitor progress and continuously adjust policies as climate risks evolve (EEA, 2026e).

At the same time, the possible measures are not automatically effective or socially equitable. Poorly designed measures could transfer risks to other locations, reinforce existing inequalities or tie infrastructure to approaches that become ineffective as climatic conditions change.

Some climate impacts might also exceed feasible adaptation limits. As such, in order to ensure that there are no regrets related to decarbonisation and electrification, flexible measures need to be prioritised that could perform under different climate and socio-economic conditions, protect essential functions and avoid increasing long-term vulnerability (EEA, 2022, 2024e).

Nature restoration and protection

Nature-based adaptation could provide a particularly strong bridge between climate resilience and nature restoration. Measures such as restoring wetlands and floodplains, reconnecting rivers, rewetting peatlands, restoring forests and soils as well as expanding urban green infrastructure can reduce exposure to floods, drought, heat and other climate hazards. They can simultaneously restore ecosystem functions and create or improve habitats.

Nature-based solutions for adaptation and disaster-risk reduction, such as restoring wetlands and floodplains, creating urban green spaces and restoring forests, can potentially benefit biodiversity, carbon sequestration, water regulation and other ecosystem services (EEA, 2023e, 2023d). In this context, adaptation investment could contribute to the recovery of natural capital rather than treating climate resilience and restoring biodiversity as separate objectives.

These synergies are not automatic, however: restoration and nature-based solutions need to be adapted to local ecological conditions and future climate scenarios. At the same time, it is necessary to monitor and manage the interventions in the long term to ensure that restored ecosystems remain resilient as climatic conditions change (EEA, 2023d, 2024e, 2025c).

Box 4.2

Current EU action supporting climate adaptation, nature-based solutions and resilient infrastructures

The EU increasingly treats climate adaptation and risk management as strategic components of economic and societal resilience. The EU adaptation strategy, adopted in 2021, aims to make Europe climate-resilient by 2050. This was reinforced by the 2024 EUCRA, which identified 36 major climate risks affecting ecosystems, infrastructure, water, food and energy security, health and financial stability.

The EC is now developing an integrated framework for European climate resilience and risk management. This is expected in the second half of 2026, to strengthen how climate risks are integrated into policymaking and investment decisions.

EU initiatives increasingly promote resilience by design, embedding climate risks into infrastructure, spatial planning and long-lived investments — particularly in transport, energy, water and buildings. Nature-based solutions form part of this approach, alongside risk prevention, preparedness and resilient infrastructure. The EU Mission on Adaptation to Climate Change supports regions and cities in assessing climate risks and developing and implementing adaptation measures, including through technical assistance, knowledge-sharing and demonstration projects. Climate-ADAPT provides accessible information, data, tools and guidance to support climate-risk assessment and adaptation planning. A growing body of EU legislation also embeds resilience and climate-proofing requirements into infrastructure planning and investment. For example, the European Climate Law requires the EU and Member States to make continuous progress in strengthening resilience and reducing vulnerability to climate change.

Meanwhile, the Critical Entities Resilience Directive (EU) 2022/2557 establishes an all-hazards resilience framework for essential infrastructure and services. These include energy, transport, drinking water, wastewater, health and digital infrastructure. The EC's 2026 guidance under the directive also highlights climate projections, flood and heat resistance, stress testing and nature-based solutions — for example, for wetlands and urban forests — as relevant resilience measures.

Sectoral and investment legislation also sets out resilience requirements. The Common Provisions Regulation (EU) 2021/1060 requires infrastructure investments supported by grants from the EU Cohesion Fund to be climate proof where the expected lifespan is at least five years.

The revised TEN-T Regulation (EU) 2024/1679 requires the European transport network to be planned and developed with greater resilience to a changing climate and geopolitical context. Meanwhile, the Environmental Impact Assessment Directive — as amended by Directive 2014/52/EU — requires relevant major projects to consider their vulnerability to climate change, major accidents and disasters.

The Floods Directive 2007/60/EC complements this framework by requiring flood-risk assessments, mapping and management plans. At the same time, the recast Energy Performance of Buildings Directive (EU) 2024/1275 incorporates climate resilience and disaster-risk resilience into national planning for building renovation.

EU funding instruments, including cohesion policy and the Recovery and Resilience Facility, support adaptation and resilience investments across regions and sectors. Together with the regulatory requirements, this increasingly means that climate resilience is a consideration in the design, financing and operation of infrastructure rather than a separate environmental policy concern.

Nature protection and restoration are also increasingly linked to economic resilience. Building on the European Green Deal and the EU biodiversity strategy for 2030, the EU increasingly recognises healthy ecosystems as natural capital supporting water regulation, pollination, soil fertility, carbon sequestration and protection against climate risks.

The EU Nature Restoration Regulation, in force since 2024, sets legally binding restoration objectives. These include measures covering at least 20% of EU land and sea by 2030 and, ultimately, all ecosystems in need of restoration by 2050. Member States are expected to submit draft national restoration plans by September 2026.

The EC is also developing a nature credits framework to mobilise private investment in ecosystem restoration, soil health and biodiversity. The initiative aims to create credible economic incentives for nature-positive investment, supported by robust methodologies, transparency and measurement.

4.1.3 European capabilities in computing, AI and next-generation biotechnology

Experts identified the development of adaptable European capabilities in computing, AI and next-generation biotechnology as a **support for competitiveness and resilience** across a broad range of future scenarios. The no-regret element would lie in maintaining the scientific, infrastructural, regulatory and industrial capabilities needed to develop, assess and deploy strategically important technologies.

This capability-based approach is consistent with recent EC and JRC assessments. These point to the value of strengthening European capacities in strategically important technologies while reducing critical dependencies and building on areas of existing scientific and technological strength (EC, 2023a; Kroll., 2024; Rodríguez-Pose and Dijkstra, 2025).

By specialising in advanced AI, high-performance computing and biotechnology, Europe could build competitive advantages in high-value segments of the global economy while avoiding direct competition based on cost alone. This approach could enable European firms and research institutions to benefit from the scale and dynamism of global markets centred around the United States and China, while differentiating themselves through scientific excellence, quality, trustworthiness and technological sophistication (Lowe, Minssen and Skentelbery, 2024; Rodríguez-Pose and Dijkstra, 2025).

Investment in these capabilities could also deliver productivity gains across the economy. Advanced AI and digital technologies might:

- improve industrial efficiency;
- optimise energy and resource use;
- support decision-making and accelerate innovation across multiple sectors.

In industry, these capabilities could also support decarbonisation by enabling predictive maintenance, more efficient management of energy and material flows as well as the management of increasingly electrified production systems with complex energy networks (EC, 2025b). They could also improve the management of supply chains and industrial infrastructure.

Biotechnology could offer opportunities in health, agriculture, industrial processes and sustainable materials. This would strengthen Europe's capacity to respond to emerging societal and environmental challenges (EC, 2024b; Lasarte López, González Hermoso and M'Barek, 2025).

Circularity and resource efficiency

AI, advanced computing, sensors and other digital technologies can improve information on products, materials and resource flows across value chains. This would enable more efficient production, predictive maintenance, longer product lifetimes, reuse and remanufacturing as well as improved recovery of secondary raw materials. Digital product information and traceability can also support circular design and help firms identify opportunities for retaining the value of products and materials.

These capabilities are particularly relevant given that Europe's material consumption remains high and progress towards greater circular material use has been limited to date (EEA, 2025c, 2026k; Chawla et al., 2026). Biotechnology could complement these approaches by making biological residues and waste streams valuable and by supporting the production of materials and chemicals from renewable feedstocks.

However, greater resource efficiency would need to translate into reductions in absolute resource use since efficiency improvements alone can be offset by rebound effects. Meanwhile, increased demand for biomass can generate additional pressures on land, ecosystems and other resources (EEA, 2025c; Sinkko et al., 2025; EEA, 2026k).

Decarbonisation and electrification

AI and advanced computing can support smart manufacturing, optimise energy demand, enable predictive maintenance and facilitate the integration of industrial production with increasingly renewable, electrified and flexible energy systems. Digital technologies can also help manage more complex electricity grids and coordinate production, storage and demand. At the same time, the water, and GHG emissions footprints of data centers remain considerably high.

The EU is investing in digitalisation, AI and advanced manufacturing through programmes such as Horizon Europe and the Digital Europe Programme (see Box 4.3). These recognise the role of the technologies in improving industrial productivity, optimising energy use and accelerating the deployment of clean technologies.

However, realising the potential of these technologies will depend on Europe maintaining strong capabilities in computing infrastructure, AI, advanced manufacturing and research and innovation ecosystems. Without sufficient technological and innovation capacity, the EU risks developing new strategic dependencies in technologies that are increasingly important to industrial transformation.

Biotechnology and biomanufacturing may further contribute to this no-regret option by replacing some fossil-based feedstocks and processes with bio-based alternatives. These approaches have particular potential in sectors that are difficult to electrify. However, the benefits depend on sourcing sustainable biomass and life-cycle performance. This is in a context where lower fossil-resource use does not necessarily translate into lower impacts across all environmental dimensions (EEA, 2025c; Sinkko et al., 2025; Coffano et al., 2026).

Climate adaptation and resilience

High-performance computing, Earth observation, sensors, AI and digital twins can improve climate and risk modelling, early-warning systems and monitoring of infrastructure, water resources and ecosystems. They can also allow decisionmakers to test alternative scenarios and anticipate interactions between climate hazards and increasingly interconnected energy, transport, water and industrial systems.

Such capabilities are becoming more important as climate-related economic losses increase and Europe faces growing risks from heat, drought, floods, wildfires and compound events (EEA, 2025b). Digital innovation can therefore strengthen the knowledge base for adaptation and improve how responses are targeted and timed. It should, however, be regarded as an enabling capability rather than a substitute for investment in resilient infrastructure, ecosystem-based adaptation and reductions in underlying vulnerability.

Nature restoration and protection

Earth observation, AI, advanced spatial analysis and digital twins can improve mapping of ecosystem conditions, identify areas where restoration could deliver the greatest benefits, monitor ecological change and evaluate whether interventions are achieving their intended outcomes. This is particularly relevant as Europe seeks to scale up restoration while large shares of its ecosystems remain degraded or in unfavourable condition (EEA, 2023e, 2023d, 2025d; Paracchini et al., 2026).

Better environmental data and modelling could also support the design and monitoring of nature-based solutions for challenges such as floods, drought, extreme heat, wildfire risk and water retention. Biotechnology may provide complementary tools — for example, through biological processes used in environmental remediation or approaches that improve the efficiency of biological resource use.

Nevertheless, these technologies should support, rather than replace, the protection and recovery of functioning ecosystems. The effectiveness of nature-based solutions ultimately depends on ecological condition, appropriate spatial planning, long-term management and reducing the pressures that drive biodiversity loss (EEA, 2023d, 2025d; Carlotti, Sala and Lettieri, 2026).

These benefits would not be automatic, however, and these technologies should be regarded as enabling tools rather than standalone solutions to environmental and economic challenges. Expanding computing infrastructure could increase demand for electricity, water and critical raw materials (EEA, 2026k, 2026a). Meanwhile, biotechnology could generate environmental, ethical and biosecurity risks (Sinkko et al., 2025).

Public support for research, infrastructure and commercialisation would therefore need to be accompanied by sustainability safeguards, effective assessment of the technology, robust competition policy and attention to possible lock-in. Under these conditions, technological capability could expand Europe's strategic options without committing it to a single technological pathway.

Box 4.3

Current EU action supporting capabilities in computing, AI and next-generation biotechnology

The EU is increasingly treating advanced digital and biological technologies as strategic capabilities underpinning competitiveness, resilience and the green transition. This approach combines investment in physical and research infrastructure, measures to strengthen industrial ecosystems and skills as well as regulatory frameworks intended to reduce strategic dependencies while accelerating innovation and deployment.

In computing, the European High Performance Computing Joint Undertaking (EuroHPC JU) is building shared European supercomputing and quantum-computing infrastructure for science, industry and public authorities. This is complemented by the European Chips Act; these seek to reinforce European capabilities in semiconductor research, design and manufacturing.

The June 2026 Tech Sovereignty Package also proposed a cloud and AI development act to expand sustainable data-centre and cloud capacity, support next-generation cloud and AI technologies and reduce dependencies in critical digital infrastructure.

AI is a central focus of the 2025 AI continent action plan. Building on EuroHPC, the EU is establishing 19 AI factories that combine computing power, data and expertise for start-ups, researchers and industry. In July 2026, it also launched a call for up to seven AI gigafactories, designed to provide the much larger computing capacity required for frontier AI models.

The InvestAI initiative is intended to mobilise public and private investment, while the apply AI strategy and AI in science strategy aim to accelerate the adoption of AI in strategic sectors and strengthen Europe's scientific capabilities. These initiatives sit alongside the AI Act, which establishes the EU framework for trustworthy and risk-based AI governance.

The expansion of digital capability also raises environmental trade-offs. As the EEA has highlighted, digitalisation is not inherently green. Data centres, networks and devices require energy, water and CRMs. Meanwhile, rebound effects can offset efficiency gains. The EEA therefore stresses the need for explicit sustainability objectives, resource- and energy-efficiency standards, circularity and systemic oversight so that digitalisation supports environmental goals rather than simply increasing overall resource demand (EEA, 2026k).

The bioeconomy is another important pillar of the EU's initiatives. In November 2025, the EC adopted a new EU bioeconomy strategy aimed at scaling the sustainable production and use of biological resources while strengthening Europe's competitiveness and resilience. The strategy seeks to accelerate the deployment of bio-based innovations, develop lead markets for bio-based materials and technologies as well as promoting the sustainable use of biomass.

It places particular emphasis on replacing fossil-based materials and products, increasing the use of secondary biomass — such as agricultural residues and organic waste — and mobilising private investment in bio-based technologies. At the same time, the strategy recognises that the expansion of the bioeconomy must remain within ecological limits and support the protection of soils, carbon sinks and biodiversity.

Biotechnology and biomanufacturing form a complementary part of this industrial transition. The EC's life sciences strategy identifies biotechnology as a strategic technology for European competitiveness and sets out measures to strengthen Europe's capacity to translate scientific excellence into industrial applications.

The proposed European Biotech Act seeks to create a more innovation-friendly regulatory framework, improve access to finance and accelerate the development and deployment of biotechnology and biomanufacturing. These measures could support bio-based production and other technologies with potential benefits for sustainability, resource efficiency and industrial competitiveness.

4.1.4 Skills, education and lifelong learning systems

Experts identified stronger skills, education and lifelong learning systems as a no-regret option because they could support sustainable competitiveness under a wide range of future conditions. Regardless of how technological change, demographic trends or geopolitical and environmental pressures develop, Europe's capacity to adapt depends substantially on the knowledge and capabilities of its people.

Stronger education and continuous learning could help:

- businesses adopt innovation;
- workers navigate industrial transformation;
- public institutions manage increasingly complex climate and environmental risks.

The value of this no-regret option would extend beyond meeting immediate labour-market shortages. By widening access to economic opportunities and supporting people through structural change, stronger skills, education and lifelong learning systems could also reinforce social cohesion and public support for sustainability transitions.

Circularity and resource efficiency

Across the scenarios, the expansion of circular economic activity could increase demand for capabilities in product design, materials science, maintenance, repair, refurbishment, remanufacturing, resource management and high-quality recycling. Combining technical knowledge with life-cycle assessment, business development and supply-chain management could help firms translate circular principles into commercially viable products and services. Training could also support the effective use of digital product passports, material-tracing systems and advanced sorting and recovery technologies.

Circularity could alter the composition and location of employment rather than simply creating additional jobs. Some activities, including repair and remanufacturing, could become more labour-intensive. Meanwhile, automation might reduce labour demand elsewhere. Continuous learning, vocational training and recognised qualifications could help workers move between activities and regions while improving job quality and occupational safety.

These capabilities could enable circular business models to expand without leaving behind workers or communities dependent on activities which are in decline. EEA analysis similarly highlights the need to combine skills development with fair wages, safe working conditions and inclusive access to emerging opportunities (EEA, 2026h).

Decarbonisation and electrification

The deployment of renewable energy, electricity grids, storage, heat pumps and low-carbon industrial processes could mean that substantially more workers with technical, engineering, construction, digital and project-management skills are required. This would build on an already significant employment base.

In 2023, the EU's wind, solar PV, heat-pump and battery sectors directly employed approximately 273,500, 227,000, 80,100 and 33,000 people, respectively. Much of

this employment was concentrated in operations, construction and installation rather than manufacturing alone (EEA, 2026d). The scenario exercise indicated that workforce capacity could become as important for deploying technology as finance, infrastructure and regulatory conditions.

The skills required would extend beyond individual technologies. A renewables-based energy system will depend increasingly on electrification, grids, storage, demand-side response, digitalisation and coordination across sectors. Systems thinking and interdisciplinary knowledge could help workers and decisionmakers manage these interdependencies.

Meanwhile, capabilities in cybersecurity, risk management and responsible AI could support the reliable operation of increasingly digitalised energy systems. EEA analysis similarly concludes that renewables, electrification and energy-system flexibility must progress together (EEA, 2025h).

Climate adaptation and resilience

Climate resilience could require new and adapted capabilities across infrastructure planning, engineering, water and land management, healthcare, emergency response, finance and public administration. Professionals will need to be able to interpret climate information, assess interacting and cascading risks and incorporate future conditions into investment and planning decisions. Continuous professional development could help to ensure that emerging knowledge is translated into standards, infrastructure projects and organisational practice.

Learning systems could also strengthen the capacity of workers and communities to manage climate-related disruption. Training will be needed to address occupational risks associated with heat, ultraviolet radiation, air pollution, pathogens and extreme weather, particularly for workers in agriculture, forestry, construction, healthcare and emergency response.

Adaptation skills could therefore include workplace risk assessment, heat-action planning, modified working practices and preventive health and safety measures. Community-level learning and participation could also help to ensure that adaptation reflects different vulnerabilities and does not reinforce existing inequalities (EEA, 2025i).

Nature restoration and protection

Expanding nature restoration and nature-positive economic activity could generate demand for expertise in ecology, soil and water management, sustainable agriculture and forestry, spatial planning, ecosystem monitoring and nature-based solutions. Combining ecological knowledge with engineering, finance, data science and business development could also help to integrate nature into infrastructure, investment and corporate decision-making. Practice-based and local knowledge will also remain important for tailoring restoration measures to particular ecosystems and communities.

Education and training could further help businesses and public authorities to recognise their dependencies on ecosystem services and assess the effects of economic activity on nature.

Nature-positive transformation will require more than a narrow set of specialist occupations. Ecological literacy across professions, including finance, procurement,

construction, agriculture and public administration, could help to embed nature considerations throughout the economy. Inclusive learning and decision-making could also ensure that local knowledge, community values and the needs of groups affected by land-use change are recognised.

Box 4.4

Current EU action on skills, education and lifelong learning

The EU has developed an extensive framework for strengthening education, training and skills. The union of skills, launched in 2025, links the development of human capital directly with competitiveness, preparedness and green and digital transitions. It is organised around strengthening foundational skills; supporting regular upskilling and reskilling; facilitating the circulation and recognition of skills within the single market; and attracting and retaining talent.

It is accompanied by an action plan on basic skills and a science, technology, engineering and mathematics (STEM) education strategic plan. These include targets intended to increase participation, particularly among women, in STEM.

The European skills agenda and its flagship pact for skills support cooperation among employers, social partners, education and training providers and public authorities. Large-scale partnerships have been established across industrial ecosystems, including renewable energy, energy-intensive industries, construction, mobility, textiles, digital technologies and agri-food. These partnerships seek to anticipate changing requirements and coordinate upskilling and reskilling within sectors and regions.

The European education area supports cooperation among Member States to improve the quality, inclusiveness and accessibility of education and training. The digital education action plan 2021-2027 complements this work by promoting digitally capable education systems and improving digital skills. A 2030 roadmap for digital education and skills is intended to build on this framework, alongside measures relating to AI literacy and the responsible use of AI in education.

Vocational education and training are supported through initiatives including the European Alliance for Apprenticeships, centres of vocational excellence and EU skills academies. Under the Net-Zero Industry Act, dedicated academies support skills development for strategic clean technologies, including for the solar energy, battery and raw materials sectors. The union of skills also envisages skills-guarantee pilots, while Erasmus+ projects support training and the development of competence across clean-energy technologies.

EU financing for education and skills is provided through programmes including the European Social Fund Plus, Erasmus+, Digital Europe and Horizon Europe. Instruments promoting micro-credentials and individual learning accounts seek to make shorter and more flexible forms of learning easier to access and recognise throughout someone's working life.

Skills policies also interact with EU measures supporting fairness and regional transformation. The Just Transition Mechanism and the Social Climate Fund support groups and territories facing disproportionate transition costs. The Council recommendation on ensuring a fair transition towards climate neutrality provides guidance on combining climate action with employment, skills and social policies. These instruments recognise that skills provision is most effective when accompanied by social protection, quality employment and place-based support.

4.1.5 Social cohesion, public trust and effective regulatory frameworks

Across the scenarios, experts identified social cohesion, public trust and effective regulatory frameworks as no-regret foundations for sustainable competitiveness. Europe's ability to manage technological, industrial and environmental change could weaken if costs and benefits are perceived as unfair, institutions lack implementation capacity or policies are fragmented and unpredictable.

Conversely, transparent decision-making, meaningful participation, social protection and credible enforcement could strengthen legitimacy while providing firms, households and investors with greater certainty. Effective regulation could also support innovation by addressing market failures, establishing common rules and protecting fundamental rights. In this kind of scenario, the central challenge will be to ensure that regulation is coherent, proportionate and responsive without weakening the environmental and social protections on which long-term prosperity and public trust depend.

Higher levels of social cohesion, public trust and effective regulatory frameworks could help:

- businesses plan and invest with greater certainty;
- workers and households manage the costs of economic and environmental change;
- public institutions implement policies more effectively and respond to emerging risks;
- society support the long-term and structural changes.

Circularity and resource efficiency

Scaling circularity could require coherent rules covering product design, chemicals, waste, repair, reuse and secondary materials. Clear definitions, standards and enforcement could provide firms with greater certainty about investing while enabling circular products and materials to move more readily within the single market. Public procurement, requirements for recycled content and credible information on sustainability could create demand and strengthen consumer confidence in repaired, reused and remanufactured products.

Circular-economy policies could nevertheless produce uneven effects for workers, consumers, regions and value chains. New requirements might impose proportionately greater costs on SMEs. Meanwhile, some circular jobs could offer low pay, insecure conditions or occupational risks.

Transparent implementation and the participation of workers, communities and smaller businesses could help to identify these effects and distribute the benefits and costs more fairly. EEA analysis indicates that integrating fairness and participation into circular-economy policy can strengthen social cohesion, economic resilience and public trust (EEA, 2026h).

Decarbonisation and electrification

Long-term and predictable regulatory frameworks could provide businesses and investors with greater confidence to commit capital to renewable energy, grids, storage, industrial electrification and low-carbon production. Coherent rules across energy, industrial, climate, circular-economy and competition policy could reduce uncertainty and help prevent infrastructure bottlenecks or conflicting investment

signals. Proportionate permitting and reporting requirements could accelerate deployment while maintaining environmental safeguards and opportunities for public participation.

The scenarios also indicated that the social legitimacy of industrial transformation could depend on how its costs, risks and opportunities are distributed. For example, energy affordability, employment effects and regional dependence on carbon-intensive industries could shape public support. Likewise, social dialogue, place-based assistance and targeted protection for affected households and workers could help maintain cohesion during structural change.

EEA analysis similarly stresses that just transitions require employment, training and social policies to be coordinated with climate and environmental measures rather than treated separately (EEA, 2024k).

Climate adaptation and resilience

Effective adaptation could depend on trusted institutions capable of coordinating across sectors and levels of government. Climate risks frequently cross administrative and sectoral boundaries. At the same time, measures relating to infrastructure, land use, water management and public health often involve multiple authorities. Clear responsibilities, access to risk information and mechanisms for coordinating investment could improve preparedness and reduce gaps or duplication.

Climate impacts and adaptation measures are unlikely to affect all regions and social groups equally. Meaningful participation could help public authorities understand different vulnerabilities, incorporate local knowledge and avoid measures that shift risks onto groups with fewer resources. Transparent decisions and targeted support could strengthen trust and increase the durability of adaptation measures.

EEA analysis shows that integrating justice into adaptation can produce more equitable and resilient communities (EEA, 2025i). This is particularly true when distributional, procedural and recognitional dimensions are considered (EEA, 2024k).

Nature restoration and protection

Nature restoration is likely to require stable regulation, long-term investment and coordination across agriculture, forestry, water, infrastructure, energy and spatial planning. Clear objectives and credible enforcement could provide greater certainty for land managers, businesses and investors.

Meanwhile, monitoring and accountability mechanisms could demonstrate whether measures are delivering ecological improvements. Effective frameworks could also create markets for nature-based innovation while preventing unsubstantiated environmental claims.

Restoration can involve trade-offs among land uses, economic activities and social priorities. Public acceptance is particularly important where measures affect farming, forestry, infrastructure development or local livelihoods. Early participation from land managers, communities and other affected groups could improve policy design and help reconcile environmental objectives with legitimate social and economic concerns. Sharing benefits fairly and recognising local and practice-based knowledge could strengthen both the effectiveness and legitimacy of nature-positive transformation.

Box 4.5

Current EU action on social cohesion, public trust and effective regulation

The EU has established several frameworks intended to improve regulatory quality, participation and implementation. The EC's better regulation agenda uses impact assessments, stakeholder consultation, evaluation and evidence review. The Regulatory Scrutiny Board provides quality control for major impact assessments and evaluations, while the have your say portal enables citizens and stakeholders to contribute to policy development.

The REFIT programme seeks to ensure that EU legislation delivers its intended benefits while reducing unnecessary costs and complexity. More recently, the competitiveness compass and the EC's simplification agenda have strengthened the emphasis on reducing administrative burdens, particularly for SMEs. The EC aims to reduce administrative burdens by at least 25% overall and by 35% for SMEs, including through omnibus proposals by the end of the 2024–2029 Commission mandate. The stated objective is to simplify implementation while protecting economic, social and environmental goals.

Social cohesion and fairness are addressed through the European Pillar of Social Rights action plan and instruments supporting groups and territories affected by structural change. The Just Transition Mechanism provides targeted support for regions most affected by the transition towards climate neutrality. Meanwhile, the Social Climate Fund addresses social impacts associated with the energy transition. The Council recommendation on ensuring a fair transition towards climate neutrality provides guidance on combining climate action with employment, skills and social policies.

In digital markets, the Digital Services Act establishes common rules intended to create a safer and more trustworthy online environment. Meanwhile, the Digital Markets Act addresses the market power of designated gatekeeper platforms. The AI Act introduces a risk-based framework for AI; this aims to protect safety and fundamental rights while supporting trustworthy innovation. Regulatory sandboxes, guidance and common standards are intended to help firms — particularly SMEs and start-ups — develop and deploy compliant technologies.

The Data Governance Act and the Data Act seek to increase access to and sharing of data while strengthening rights, safeguards and trust. Together with common European data spaces, these measures could support research, public administration and innovation in areas including energy, environment, mobility, health, agriculture and skills.

4.1.6 Maintaining an active EU role in global standard-setting in environmental and social sustainability and relevant multilateral institutions

Across the scenarios, experts identified continued international engagement as a no-regret option. This is because climate change, biodiversity loss, pollution, resource security and digital governance cannot be managed effectively by Europe acting alone. An active role in multilateral institutions, scientific bodies and organisations for standardisation could help the EU:

- preserve channels for cooperation;
- shape emerging rules;
- coordinate responses to shared risks.

Internationally aligned standards could also reduce regulatory fragmentation and provide more predictable conditions for trade and investment (OECD, 2017). Their

value could persist across different futures. In an integrated global economy, they could facilitate exchange and reduce transaction costs; in a more fragmented world, technical networks and multilateral institutions could maintain cooperation even where wider political relations deteriorate.

The EU's influence should not, however, be taken for granted. European requirements could be perceived as protectionist if developed without adequate consultation or if they impose disproportionate costs on trading partners. Maintaining influence would therefore depend on regulatory credibility, diplomatic and technical capacity, meaningful international partnerships and Europe's continued importance as a market, source of investment and provider of sustainable technologies.

The no-regret element of this option lies in preserving Europe's capacity to cooperate, diversify relationships and shape international rules while avoiding either isolation or excessive dependence on individual geopolitical partners.

Circularity and resource efficiency

International alignment on product durability, repairability, recycled content, material traceability and the treatment of waste and secondary materials could support more circular global value chains. Common or mutually recognised standards could reduce compliance costs, make it easier to trade high-quality secondary materials and limit competition based on weaker environmental safeguards (EC, 2020a). European firms could benefit where EU approaches became internationally recognised, particularly in areas such as ecodesign, product information and resource-efficient manufacturing.

Partnerships with countries in Africa, Asia and Latin America could also diversify access to CRMs while supporting processing capacity, employment and economic development in partner countries (EC, 2025d). Such relationships could prove more durable if based on mutual interests, and credible environmental and social safeguards rather than resource access alone.

Nevertheless, international engagement would need to be accompanied by reductions in material demand, substitution, circularity and improved European industrial capacity. Diversifying suppliers could mean that supply chains are less reliant on certain sources for materials. However, this would not eliminate dependence or the environmental impacts associated with growing resource demand.

Decarbonisation and electrification

Common approaches to carbon accounting, product emissions, clean-technology performance and sustainable finance could improve the comparability of investments and reduce fragmentation in emerging low-carbon markets. International cooperation could also support compatible technical standards for electricity systems, batteries, hydrogen and other clean technologies. This could mean that the markets for European firms expand. It could also facilitate the diffusion of technologies needed for global emission reductions.

Multilateral climate cooperation could remain valuable even in futures characterised by geopolitical rivalry. Scientific bodies and technical institutions could continue to exchange knowledge, while common standards could provide a basis for trade and investment even if broader political agreement remained limited. The scenarios did indicate, however, that regulatory influence would be most credible where the EU demonstrated effective domestic decarbonisation, maintained strong technological

capabilities and considered the effects of its own environmental regulations on developing economies.

Climate adaptation and resilience

International scientific and technical cooperation could improve access to climate observations, risk assessments, early-warning systems and knowledge about adaptation. Shared standards for resilient infrastructure, financial risk disclosure and disaster preparedness could help public authorities and investors account more consistently for future climate conditions. Cooperation would be particularly important for transboundary risks affecting river basins, food systems, energy networks, health and supply chains.

Multilateral institutions could also help to mobilise adaptation finance and build capacity in countries with fewer resources (EC, 2021b). More resilient partner countries and value chains could, in turn, reduce any disruption affecting the European economy. These benefits would depend on international arrangements reflecting different vulnerabilities and capacities. Approaches developed primarily around European circumstances might be ineffective or inequitable if transferred without being adapted to local conditions and without meaningful participation by affected communities.

Nature restoration and protection

Biodiversity loss and ecosystem degradation are global and often embedded in international production and trade. Active participation in international environmental governance could allow the EU to help shape objectives and standards concerning biodiversity protection, ecosystem restoration, sustainable agriculture and forestry, nature-related information and responsible investment. Greater alignment could help limit the displacement of environmental pressures beyond Europe and provide more consistent conditions for firms operating across jurisdictions.

International standards and cooperation could also create opportunities for European firms providing ecosystem monitoring, environmental services, restoration technologies and nature-based solutions.

However, nature-positive approaches would need to respect different ecological and social contexts, land rights and local knowledge. Credible EU leadership would therefore depend on reducing Europe's own global environmental footprint and ensuring that international initiatives provide tangible benefits for partner countries and local communities.

Box 4.6

Current EU action on global environmental and social sustainability standards

The EU's international influence operates through multiple related channels including its participation in multilateral institutions and standard-setting processes, alongside the external effects of policies applying to economic actors participating in the single market. These channels allow the EU to contribute to objectives agreed internationally while encouraging their implementation through trade, investment, corporate and product policies.

The overarching global framework remains the United Nations 2030 agenda for sustainable development and its 17 sustainable development goals (SDGs). The EU has integrated the SDGs into its internal and external policies and participates in international follow-up through the UN high-level political forum on sustainable development.

The Pact for the Future, adopted by UN member states in 2024, reaffirms the 2030 agenda and addresses reform of global governance, sustainable-development finance, digital cooperation and the interests of future generations. Its annexes include the Global Digital Compact and the Declaration on Future Generations.

The Sevilla Commitment, adopted at the fourth international conference on financing for development in 2025, renewed the international framework for financing sustainable development. It addresses investment, debt, domestic-resource mobilisation and reform of the international financial architecture. Together, the Pact for the Future and Sevilla Commitment provide building blocks for discussions about global governance in the area of sustainable development beyond 2030.

In environmental governance, the EU and its Member States participate in the United Nations Framework Convention on Climate Change and the Paris Agreement and coordinate positions in international climate negotiations. Under the convention on biological diversity, the EU contributed to the negotiations leading to the Kunming–Montreal global biodiversity framework; this establishes global goals for 2050 and targets for 2030. The EU also participates in multilateral agreements concerning chemicals, hazardous waste, ozone depletion and international wildlife trade.

The EU remains engaged in negotiations under the United Nations Environment Programme towards a legally binding instrument on plastic pollution. Negotiations at the resumed fifth session in August 2025 concluded without consensus on a treaty text. A further organisational session in February 2026 appointed a new chair. Preparations for continued negotiations are now under way. The process illustrates both the importance and difficulty of establishing common rules where countries have different economic interests and regulatory preferences.

Trade policy provides another interface between EU sustainability objectives and the global economy. Under the World Trade Organization, the EU participates in discussions on trade and environmental protection. EU trade agreements, preference schemes and sustainable-investment partnerships complement this engagement by linking economic cooperation with environmental and social commitments. The Global Gateway and strategic partnerships on raw materials seek to support infrastructure, investment and more diversified supply relationships.

The EU also promotes convergence in corporate reporting and sustainable finance. The European sustainability reporting standards were developed in such a way that they would be interoperable with frameworks including those of the International Sustainability Standards Board and the Global Reporting Initiative.

The EU Taxonomy has become a reference in international discussions concerning environmentally sustainable activities. Through the EU-initiated international platform on sustainable finance, participating jurisdictions cooperate to try to ensure that sustainable-finance frameworks are interoperable and comparable.

EU legislation can also influence practices beyond Europe. Measures such as the Carbon Border Adjustment Mechanism, corporate sustainability requirements and product standards seek to reduce carbon leakage, improve accountability and establish more consistent conditions for firms operating in the EU market. These measures are not equivalent to multilaterally agreed standards and may result in adjustment costs or concerns among trading partners. Their international legitimacy therefore depends on transparency, consultation, consistency with international obligations and support for countries with limited implementation capacity.

4.2 From foresight to action — advancing long-term sustainable competitiveness

The no-regret options discussed above should be understood as robust strategic directions rather than fixed policy packages to be implemented in an unchanging way through to 2040. The context will continue to evolve. As such, policies will need to be monitored, evaluated and adjusted regularly. Periodic reassessment will be necessary to identify emerging risks, manage trade-offs and avoid creating new technological, environmental or social lock-ins.

Progress will depend not only on investment and technological innovation but also on:

- the availability of skills;
- well-functioning markets;
- institutional capacity;
- public support;
- coordinated action across sectors and levels of governance.

These interdependencies need to be recognised when policies are designed, sequenced and implemented.

That said, Europe's long-term competitiveness will depend not only on its capacity to innovate and improve productivity but also on its ability to maintain the environmental, social and institutional foundations of prosperity. Vulnerabilities can be reduced by:

- scaling up circular economy practices;
- accelerating decarbonisation;
- strengthening resilience;
- restoring nature.

These actions can also create opportunities for investment, innovation and employment. However, their contribution will ultimately depend on how they are implemented: whether they effectively reduce environmental pressures, distribute costs and benefits fairly while also enhancing Europe's capacity to adapt and prosper under conditions of uncertainty (EEA, 2024h, 2024e, 2025d).

Being competitive by nature therefore does not describe a final state or a single pathway to 2040. It provides a direction for strategic action — creating economic value while maintaining and strengthening the natural and social capital on which future prosperity depends.

The no-regret options identify practical areas which could guide Europe across a range of plausible futures.

- Circularity can reduce the material and energy requirements of industrial transformation.
- Digital technologies can improve material traceability, energy-system management and environmental monitoring.
- Skills enable technologies and practices to diffuse.
- Effective institutions provide investment certainty and legitimacy.
- International cooperation can support common standards and more resilient supply chains.
- Nature restoration can reduce climate risks, but its effectiveness also depends on finance, knowledge, institutional capacity and public support (EEA, 2023e, 2023d).

Actions in one area may nevertheless create pressures elsewhere. For example, electrification can reduce fossil-fuel dependence while increasing requirements for grids and critical materials. Extending the lifetime of buildings and infrastructure can support circularity but may preserve inefficient or climate-vulnerable assets. Bio-based production can substitute for fossil resources while increasing the pressures on land, water and ecosystems.

Sustainable competitiveness therefore depends on identifying synergies while actively managing trade-offs. It also involves avoiding the transfer of risks between sectors, places and generations.

These considerations are reflected in the findings from the Delphi survey. Respondents generally did not expect the EU to have achieved the whole range of 2040 objectives by 2040. The scale of ambition is great — from attaining a highly advanced circular economy to fully decarbonising hard-to-abate industries and attaining resilience to cascading climate and environmental risks.

The insights from the survey do not suggest that these objectives are irrelevant. Rather, they pointed to a gap between long-term ambition and the pace and scale of implementation (Kimpeler et al., 2026). The findings suggest that the principal challenge is not an absence of EU objectives or policies since the EU already has a substantial policy foundation.

The challenge is in translating these commitments into coordinated implementation and economy-wide change. Recent EEA assessments similarly emphasise the need to maintain long-term sustainability objectives in a volatile policy environment and embed them in evolving priorities relating to competitiveness, security and fairness (EEA, 2024i, 2025d).

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5 Conclusions

Europe's socio-economic model stands at a pivotal moment, shaped by the energy transition, industrial transformation, technological change, geopolitical instability and the pursuit of greater strategic autonomy. This report has examined how these developments could reshape the relationship between environmental sustainability and competitiveness. Its central conclusion is that the two cannot be treated as separate objectives over the long term.

As discussed in Chapter 2, this is particularly important in relation to Europe's material and ecological conditions. Europe does not possess abundant domestic reserves of fossil energy or the extensive land and resources that could support a development model based on continually expanding extraction and material throughput. At the same time, its economies remain deeply dependent on energy, materials, ecosystems and global supply chains.

Resource efficiency, circularity, decarbonisation, climate adaptation and nature restoration are therefore not simply approaches which can be added on to environmental and competitiveness objectives. They increasingly form essential factors in maintaining economic resilience and reducing strategic vulnerabilities for Europe.

The foresight analysis developed in Chapters 3 and 4 demonstrates that the conditions under which Europe competes may evolve in markedly different ways. Despite these uncertainties, several strategic no-regret options that retain value across multiple scenarios were identified.

Investment in circularity, resilient infrastructure, ecosystems, skills, innovation and institutional capacity can expand Europe's room for manoeuvre — its ability to:

- respond when circumstances change;
- act when opportunities emerge;
- avoid becoming locked into pathways that progressively narrow future choices.

This points to the concluding interpretation of what it might mean for Europe to be **competitive by nature**. The concept should not imply simply making nature serve economic objectives more efficiently nor treating sustainability as an external constraint on an otherwise autonomous economic system.

Rather, it points to the need to recognise the conditions within which economic activity takes place:

- finite ecological resources;
- increasingly complex technological infrastructures;
- interconnected societies;
- a geopolitical environment in which dependencies can become sources of vulnerability.

Europe's strategic challenge is ultimately to develop the capabilities to navigate these conditions while continuing to create prosperity and adapt to change. In this sense, competitiveness is not a fixed destination but an ongoing capacity for renewal: the capacity to innovate, govern structural change, reduce vulnerabilities and maintain the conditions for future prosperity.

List of abbreviations

Abbreviation	Name
AI	Artificial Intelligence
CISL	Cambridge Institute for Sustainability Leadership
CRM	Critical raw material
EC	European Commission
ECB	European Central Bank
EEA	European Environment Agency
EIB	European Investment Bank
Eionet	European Environment Information and Observation Network
ETC ST	European Topic Centre on Sustainability Transitions
EU	European Union
EUCRA	European Climate Risk Assessment
EuroHPC	European High Performance Computing Joint Undertaking
EU-27	27 Member States of the European Union
gCO_2e/kWh	Grams of carbon dioxide equivalent per kilowatt-hour
GDP	Gross Domestic Product
GHG	Greenhouse gas
JRC	Joint Research Centre
PV	Photovoltaic
SDG	Sustainable Development Goal
SME	Small and medium-size entreprise
STEM	Science, technology, engineering, and mathematics

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Annex 1 Scenarios for Europe in 2040

This Annex presents the five scenarios developed through the qualitative foresight exercise. The scenarios explore how different combinations of geopolitical, technological, economic, environmental and societal developments could shape the conditions for Europe's competitiveness and sustainability towards 2040. They are not forecasts, preferred futures or alternative policy programmes. Instead, they provide exploratory contexts for identifying emerging opportunities, vulnerabilities and strategic tensions.

The scenario-building process began with the identification of eight contextual factors and their possible future trajectories, described in Chapter 3. A morphological scenario approach was then used to explore how these developments could interact and combine. This made it possible to consider relationships across different areas of change rather than examining each factor separately or extrapolating a single expected future.

The morphological analysis was conducted through a structured expert workshop. Starting from an initial trajectory for one contextual factor, participants identified compatible developments across the remaining factors and excluded combinations considered internally contradictory or unlikely to coexist. The resulting configurations were assessed according to their internal coherence, plausibility, relevance to European policy challenges and capacity to represent contrasting future conditions.

Five scenarios were selected and subsequently refined by developing their defining characteristics and assessing their implications for Europe's competitiveness and sustainability:

- **Sunrise in the South — the African–Asian century**, in which economic and political influence shifts towards Africa and Asia within a more multipolar global order;
- **The age of fragmentation — a world in competition**, characterised by resource nationalism, fragmented trade and technological systems and intensifying climate pressures;
- **From nations to networks — AI-enabled governance**, in which governance functions become increasingly distributed across technology platforms, regional authorities, communities and private infrastructure providers;
- **Status quo 2.0 — Western cohesion and balanced alliances**, marked by revitalised Western cooperation and relatively open trade but also by persistent technological, resource and energy dependencies;
- **China-led convergence**, in which global economic and technological integration increasingly develops around Chinese manufacturing, infrastructure and standards.

The scenarios bring together contrasting assumptions about the distribution of global power, the degree of international cooperation, the organisation of governance and the pace and direction of technological, economic and environmental change. Their purpose is to broaden the range of future conditions considered and explore how Europe's competitiveness and sustainability could be affected if different combinations of developments occur.

Despite their differences, the scenarios reveal several recurring vulnerabilities. These include:

- dependence on imported energy, materials and technologies;
- exposure to climate and environmental disruption;
- uneven access to skills and infrastructure;
- risks to social cohesion and institutional trust.

They also highlight recurring opportunities associated with resource efficiency, resilient infrastructure, technological and institutional capabilities as well as international cooperation.

Comparing these different futures provided the basis for identifying the no-regret options presented in Chapter 4. The options reflect strategic directions that participating experts considered potentially valuable across several plausible futures rather than responses tailored to any single scenario. The following sections present the five scenario narratives in full.

Scenario 1

Sunrise in the South — the African–Asian century

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In this scenario, economic and political influence shifts substantially towards Africa and Asia. Rapid growth, innovation and productivity gains increase the shares of global output, resource demand and technological development held by these regions. Europe's relative influence declines as emerging economies gain greater capacity to shape markets, standards and international institutions.

China remains an important political and economic actor across both regions, but it operates within a broader redistribution of global power rather than as the sole centre of influence. For Europe, this transformation creates more intense competition for raw materials and access to rapidly expanding markets. From a global equity perspective, however, this shift also reflects a broader distribution of economic opportunities, resources and international influence.

Resource constraints accelerate circularity, material efficiency and changes in consumption within Europe. European firms seek comparative advantages in climate adaptation, environmental services, trustworthy digital governance and selected clean technologies. Partnerships with African and Asian countries increasingly depend on reciprocal economic benefits, knowledge exchange and credible environmental and social safeguards rather than resource access alone.

Competition in digital technologies also intensifies. China consolidates strengths in digital infrastructure; many African countries rapidly expand their digital public services; and the United States retains advantages in AI and biotechnology. In this context, Europe remains influential in areas such as privacy, trustworthy AI, digital regulation and environmental standards. However, regulatory capabilities produce economic advantages only where they are supported by innovation, investment and access to international markets.

Scenario 2

The age of fragmentation — a world in competition

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In this scenario, the EU's sustainability ambitions come under increasing pressure from resource nationalism, fragmented trade systems and intensifying climate impacts. At the same time, the EU's competitiveness is challenged by diverging technological standards, fragile supply chains and continued dependence on imported AI hardware, CRMs and other strategic inputs.

The absence of a coordinated approach to energy sourcing further increases the EU's vulnerability. Price volatility, supply disruptions and uncertainty in global energy markets undermine industrial decarbonisation efforts, discourage long-term investment and weaken Europe's ability to maintain a competitive industrial base.

Meanwhile, the growing frequency and severity of climate-related impacts — including floods, droughts and water scarcity — raise adaptation costs, place additional pressure on public finances and exacerbate existing social inequalities. These developments make it more difficult to ensure a just transition and maintain public support for sustainability policies.

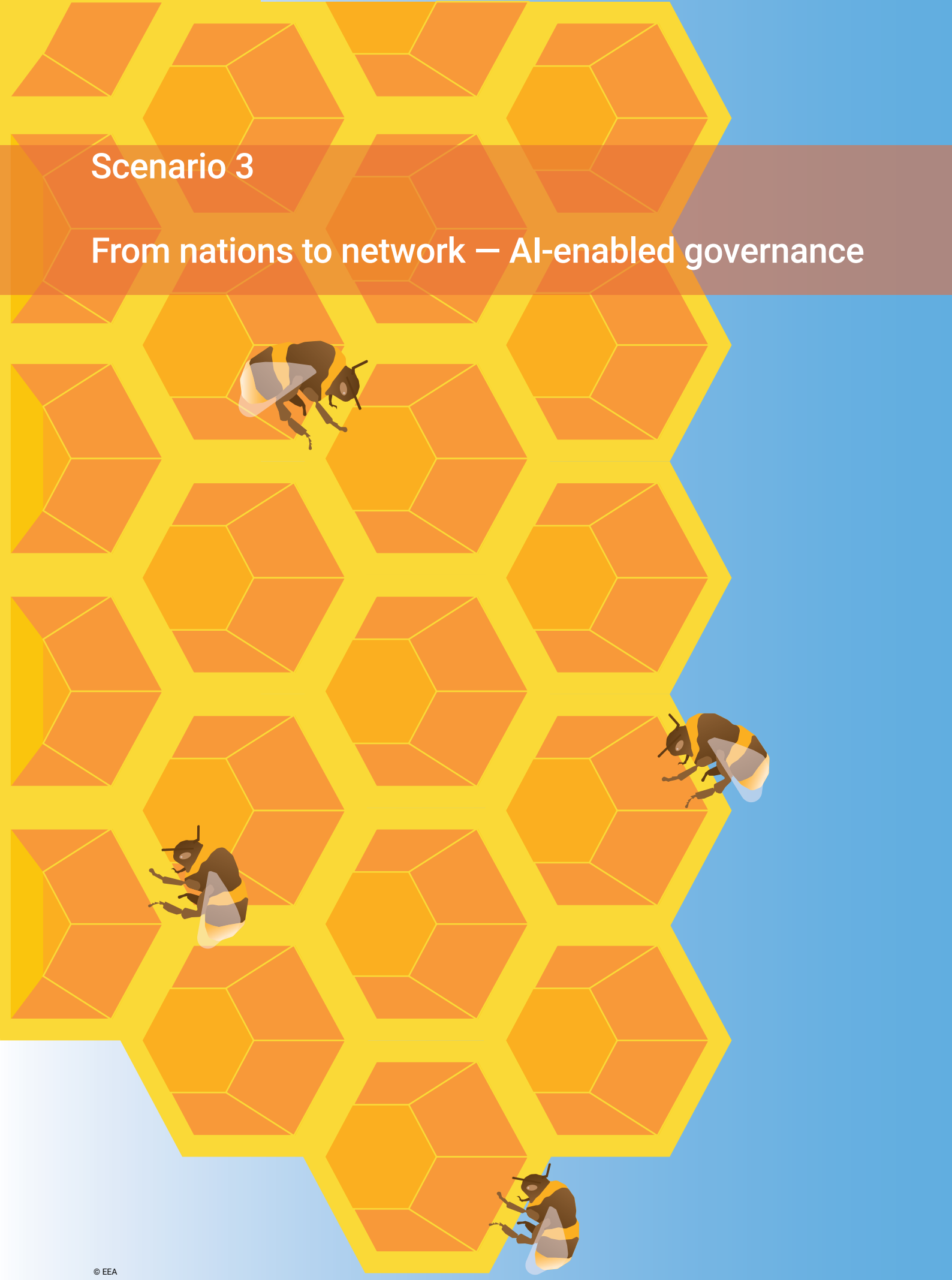
Governance challenges further complicate the picture. Declining trust in institutions, combined with the growing influence of AI-enabled disinformation and external information campaigns, slows decision-making processes and weakens the implementation of long-term policy objectives. As a result, Europe faces increasing difficulties in coordinating collective responses to interconnected economic, technological and environmental challenges.

Despite these pressures, Europe retains capabilities that provide some resilience. Europe's commitment to a human-centric approach to AI, regulatory frameworks and sustainability standards remain sources of trust and differentiation in some markets. Cooperation continues with selected partners, although diverging technological and environmental standards limit interoperability and increase compliance costs.

Circularity, more secure digital and energy infrastructure and reduced dependence on concentrated supply chains partially cushion external shocks. However, fragmented governance, high adaptation costs and weak international cooperation limit the scale and speed of implementation. Europe consequently preserves parts of its industrial and sustainability agenda but struggles to coordinate the systemic transformation required to realise their full benefits.

Scenario 3

From nations to network — AI-enabled governance



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In this scenario, competitiveness and sustainability unfold in a world where the basic structures of governance have changed. As national institutions lose coordinating capacity, governance functions become distributed between technology platforms, regional and municipal authorities, community networks and private infrastructure providers. This creates space for local experimentation but also produces substantial inequalities in access, capability and accountability.

Traditional state authority weakens while networks built around AI systems, data platforms and digital infrastructures take on major roles in organising economies and public services. At the same time, global scarcity of raw materials, chips and usable data limits industrial growth and puts pressure on all regions, including Europe.

Sustainability is not a universal priority across society. While some actors actively pursue environmental and social objectives, others focus primarily on economic gains, local community development, security or individual well-being. As a result, progress towards sustainability is uneven and emerges through a combination of intentional initiatives and practical necessity rather than through a shared societal vision.

In some areas, sustainability benefits from a democratic renewal characterised by locally driven initiatives, community engagement and experimentation with alternative governance models. Resource constraints encourage the adoption of circular economy practices, while decentralised energy systems expand in response to the need for greater self-sufficiency and resilience. These developments contribute to more sustainable outcomes, even when sustainability itself is not the primary objective.

Europe's competitiveness, however, faces significant challenges. Global shortages of CRMs, increasing competition for strategic resources and a growing divide in access to computing power and data limit the capacity of European firms to innovate and scale. Dependence on imported semiconductors, advanced computing infrastructure and CRM remains a key vulnerability.

At the same time, rising geopolitical tensions contribute to a fragmented global digital landscape. This further restricts access to data, technologies and international markets.

AI helps some societies anticipate and manage climate and environmental pressures. AI-enabled forecasting systems, early-warning mechanisms and locally coordinated response systems improve preparedness and support adaptive decision-making.

However, the concentration of data and computing resources in the hands of a limited number of actors creates new governance, accountability and security challenges. Limited human oversight over increasingly complex digital systems further increases concerns regarding transparency, democratic control and systemic risks.

Governance in this scenario relies heavily on decentralised and principle-based forms of coordination. These arrangements help maintain essential societal functions and support evidence-based policymaking, particularly at the local level. However, the absence of strong coordination across regions and sectors can result in fragmented markets, disconnected energy systems and incompatible standards. Such fragmentation may limit economies of scale, reduce interoperability and increase costs. This constrains both competitiveness and the broader diffusion of sustainable innovations.

Overall, this scenario depicts a Europe that remains functional and adaptive despite growing resource constraints and geopolitical fragmentation. Local innovation, decentralised governance and AI-supported adaptation provide important sources of resilience. However, weak coordination and persistent technological dependencies limit Europe's capacity to scale innovation and pursue common sustainability objectives.

Scenario 4

Status quo 2.0 — Western cohesion and balanced alliances

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In this scenario, the EU benefits from a revitalised Western alliance, open international trade and effective climate adaptation measures that help limit the impacts of increasingly frequent climate hazards. These conditions create a relatively favourable environment for economic cooperation, innovation and investment.

At the same time, however, sustainability objectives face growing pressure from rising levels of consumption, increasing demand for energy and natural resources as well as an energy system that remains fragmented across regions and Member States.

Europe's competitiveness is strengthened by a highly integrated and tariff-free economic space characterised by interoperable standards, close transatlantic cooperation and strong innovation networks. These conditions facilitate trade, knowledge exchange and technological development.

Nevertheless, significant vulnerabilities remain. The global AI landscape continues to be dominated by a small number of largely American and Chinese technology companies, while control over critical computing infrastructure and advanced hardware remains concentrated among a limited group of actors. This dependence constrains Europe's technological sovereignty and limits its ability to shape the direction of emerging technologies.

Labour market challenges further complicate the picture. Rapid technological change contributes to widening skills gaps, making it difficult for businesses and public institutions to fully capitalise on innovation opportunities. At the same time, declining public trust in institutions and governance processes can slow policy implementation and reduce societal support for necessary reforms. This creates obstacles to long-term competitiveness and sustainability objectives.

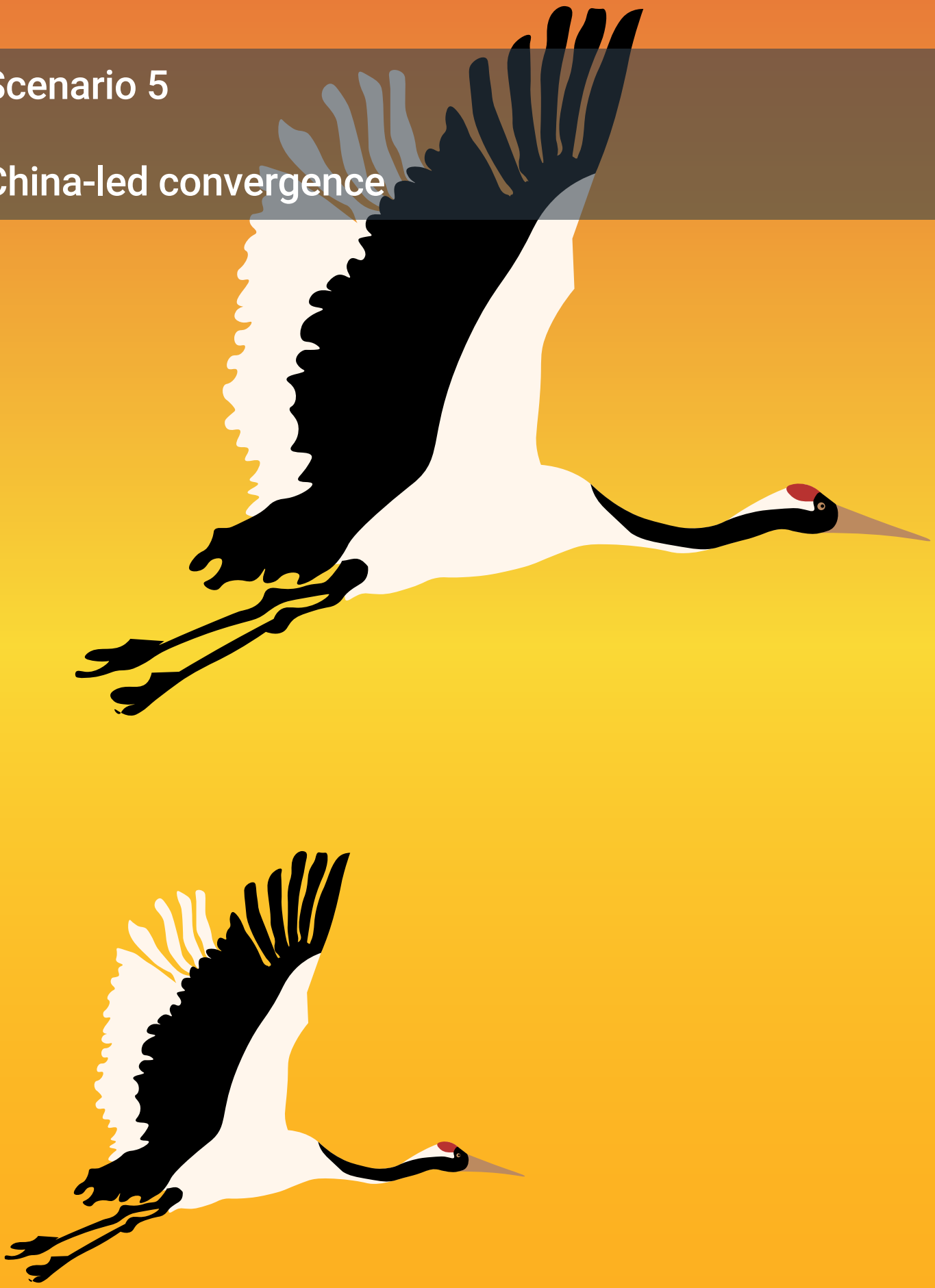
Although Europe has made progress in improving resilience and reducing some strategic dependencies, persistent global shortages of CRMs and other key inputs continue to pose supply risks. In addition, uneven progress in the development and integration of energy systems across Europe results in limited cross-border electricity flows and continuing regional disparities. These constraints increase costs, reduce efficiency and limit the ability to achieve economies of scale.

Strengthening international cooperation and evidence-based policymaking provides opportunities for Europe to play a leading role in setting global standards on issues such as ethical AI, digital governance, cybersecurity and sustainability. However, the continued concentration of market power among a small number of technology firms, combined with growing cybersecurity threats, raises concerns regarding resilience, strategic autonomy and economic security.

Overall, in this scenario Europe benefits from open markets, Western cooperation and comparatively effective institutions but does not overcome several longstanding structural weaknesses. Its competitiveness improves incrementally, while continued dependencies, skills shortages and uneven energy integration constrain deeper economic and environmental transformation.

Scenario 5

China-led convergence



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Unlike the more multipolar economic shift depicted in 'Sunrise in the South', this scenario is characterised by convergence around a highly integrated global economy in which China plays the principal coordinating role in manufacturing, infrastructure, trade and technological standards.

In this scenario, the EU's environmental integrity and competitiveness are reinforced by a tariff-free, highly interconnected global market and close economic collaboration with China. Greater interoperability reduces transaction costs and accelerates the diffusion of technology, but Europe has less influence over the values and governance models embedded in global standards. Formal alignment on sustainability or AI governance does not necessarily imply convergence on transparency, rights or accountability.

Europe benefits from a strong reputation in trusted and human-centric AI, as well as from its leadership in clean technologies, sustainability-oriented innovation and environmental governance. Investments in resilient infrastructure, digital connectivity and decentralised energy systems contribute to lower GHG emissions, improved energy security and reduced dependence on fossil fuel imports. Together, these developments strengthen Europe's ability to combine economic prosperity with environmental sustainability.

Close cooperation with China provides access to large markets, investment opportunities and advanced manufacturing ecosystems. These support European industries and accelerate the deployment of low-carbon technologies.

However, this relationship also creates new strategic challenges. Despite efforts to diversify supply chains and improve resource efficiency, Europe remains dependent on imports for CRMs, advanced technologies and key components. These dependencies expose the European economy to geopolitical risks and external disruptions. This raises concerns about long-term resilience and strategic autonomy.

Furthermore, the growing concentration of power among a limited number of actors controlling data, computing infrastructure and advanced digital technologies creates challenges related to market dominance, technological sovereignty and fair competition. While global integration generates significant opportunities for innovation and productivity gains, it may also increase competitive pressures on European firms. This is particularly the case for SMEs which can struggle to compete in highly concentrated international markets.

Another challenge arises from the potential rebound effects associated with continued economic growth and rising consumption. Technological progress, efficiency improvements and lower trade barriers may reduce the environmental intensity of production, but they can also stimulate additional demand for energy, materials and consumer goods. Without effective governance and sustainable consumption patterns, these dynamics risk offsetting some of the environmental gains achieved through technological innovation and circular economy measures.

Overall, this scenario depicts a Europe that benefits from openness, rapid diffusion of technology and close economic ties with China, while advancing sustainability through innovation, circularity and clean technologies.

However, Europe's competitiveness remains contingent on its ability to balance the benefits of deep global integration with greater strategic autonomy in critical technologies, digital infrastructure, raw materials and clean energy systems. Its prosperity depends on deep integration, while its resilience is constrained by continuing dependencies in critical technologies, materials and infrastructure.

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