European Environment Agency

# Imagining a sustainable Europe in 2050:
## Exploring implications for core production and consumption systems

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# Key messages

- To turn the EU's long-term vision of 'living well, within environmental limits' by 2050 into a reality, fundamental changes need to be made to the production and consumption systems that deliver on Europe's demand for energy, food, mobility and shelter. In this context, collectively reflecting on desirable futures helps instil hope and guide action.
- A set of imagined futures, or 'imaginaries', developed by the EEA and its country network — Eionet — were used to explore how the future of Europe's production and consumption systems might unfold and identify challenges and opportunities.
- Core systems of production and consumption are deeply intertwined, which means that interventions in one system will have multiple knock-on effects on other systems.
- Areas where actions have the potential to transform core production and consumption systems towards sustainability typically exhibit one or more of the following traits: they catalyse deep changes within several possible futures; they impact across systems; and/or can be operationalised within multiple European regions.
- The shift to alternative protein sources, the use of nature-based solutions, the decarbonisation of mobility, the repurposing and renovation of existing buildings, and the expansion of renewable energy systems are just some of the solutions identified in the report as enabling sustainability across all four futures.
- To navigate processes of systemic change and build resilience to future disruptions — from global unrest to climate breakdown or digital collapse — there is a need to strengthen societal capacities in key areas. These areas include: collaborative and anticipatory governance; societal engagement and creativity; connection to nature and empathy; spatial planning and multifunctional land use; AI and digitalisation; and preparedness for shocks, where strategic foresight plays a central role.

# Executive summary

In this foresight report, the European Environment Agency (EEA) uses four imaginaries of a sustainable Europe in 2050 — a set of imagined futures offering contrasting images of what a sustainable Europe could look like — as lenses through which to explore what sustainable systems of production and consumption might emerge in the future (for more information on the imaginaries published by the EEA in 2022, please follow the links in Box ES 1).

## Box ES 1

**Explore the four imaginaries**

**Imaginary 1: Technocracy for the common good**

**Imaginary 2: Unity in adversity**

**Imaginary 3: The great decoupling**

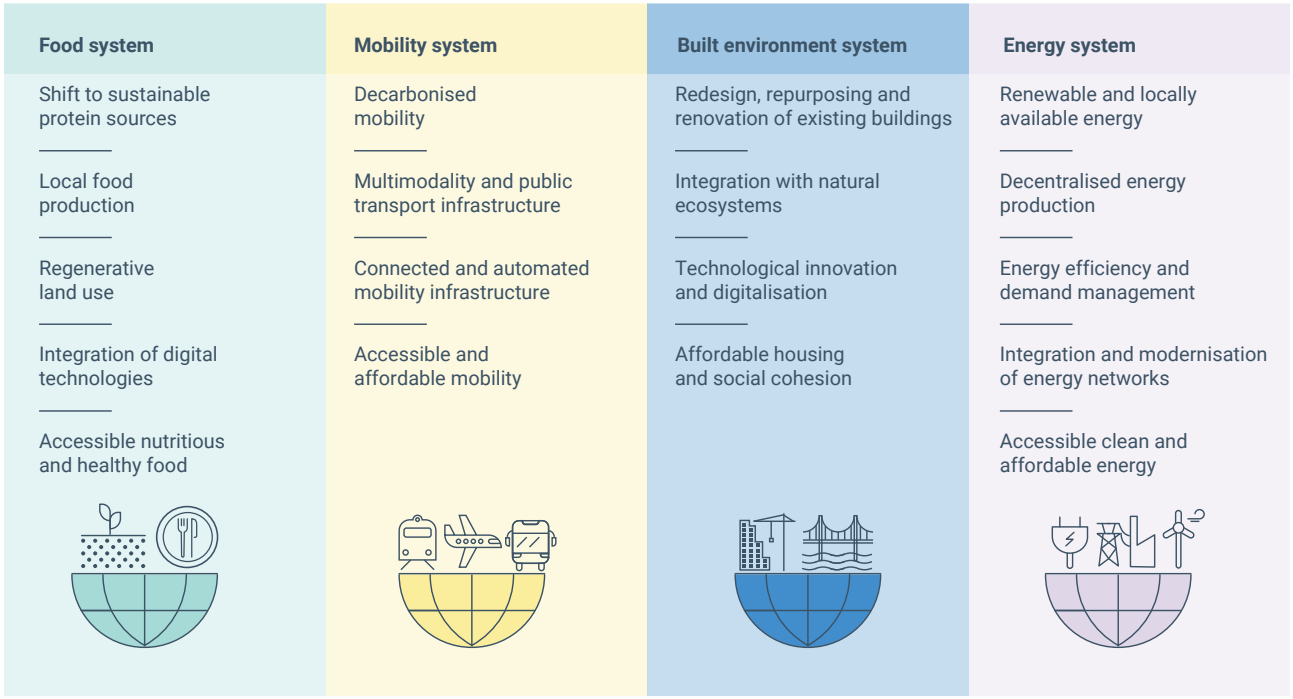
**Imaginary 4: Ecotopia**

**Source:** EEA 2022a.

On the one hand, these systems deliver on Europe's vital needs for energy, food, mobility and shelter. On the other hand, these same systems cumulatively drive climate and environmental pressures and impacts in Europe and across the globe. This report draws on qualitative evidence emerging from seven online participatory workshops that harvested the collective intelligence of a range of experts, complemented by desk-based research and expert interviews.

The four imagined futures, or 'imaginaries', represent possible sustainable futures for Europe in 2050. The report delves into the main characteristics of Europe's core production and consumption systems in 2050, namely the food, mobility and energy systems and the built environment, identifies challenges and opportunities across the four different futures and reflects on the interactions between systems. It also highlights areas where actions have the potential to transform core production and consumption systems towards sustainability. Such areas typically exhibit one or more of the following traits: they catalyse deep changes within several possible futures; they impact across systems; and/or they can be operationalised within multiple European regions (see Figure ES 1).

**Figure ES 1** **Areas of transformative potential within core production-consumption systems**




**Source:** EEA.

Similarly to today, the production and consumption systems that make life possible within each imaginary are deeply intertwined, which means that interventions in one system will have multiple knock-on effects on other systems. To better anticipate possible future system interactions, the report highlights interdependencies between production and consumption systems that represent important areas of governance and policy intervention. One of these areas is 'cross-system innovation and circularity', highlighting the importance of identifying and supporting the development, diffusion and adoption of innovations that sit at key interfaces between systems and can contribute to closing loops and moving towards circularity.

Future disruptions — plausible extreme developments in Europe or worldwide that could, if they came about, markedly change the policy landscape — were used to explore and stress-test the plausible positive futures depicted in the imaginaries. This exploration helped to identify important vulnerabilities, wherein small failures might cascade and combine to create a progressive erosion of social trust and societal cohesion, threats to democracy and critical infrastructure. It also helped to identify a set of capacities that could help society to navigate processes of systemic change towards long-term environmental and socio-economic goals and build resilience (see Figure ES 2). These can be grouped according to the following thematic clusters:

- collaborative and anticipatory governance;
- societal engagement and creativity;
- connection to nature and empathy;

- spatial planning and multifunctional land use;
- AI and digitalisation;
- preparedness for shocks.

**Figure ES 2** **Capacities for transformative change**

| | | | |
|---|---|---|---|
| **Collaborative and anticipatory governance** | Collaborative multilevel governance<br>Anticipatory governance | Adaptive and inclusive governance frameworks<br>International cooperation and multilateralism | Global citizenship and solidarity |
| **Societal engagement and creativity** | Engagement of citizens in decision making | Engagement of organised civil society in decision making | Human creativity and innovation |
| **Connection to nature and empathy** | Deep connection to nature | Education for empathy and collective well-being | |
| **Spatial planning and multifunctional land use** | Spatial and urban planning | Multifunctional land use | |
| **AI and digitalisation** | Safe and trustworthy AI deployment for the public good | Technological independence and resilience in digital infrastructure | |
| **Preparedness for shocks** | Futures literacy and foresight<br>Resilient public care and education infrastructure | Financial buffering and sustainable investment<br>Self-sufficiency at the local level | Disaster preparedness and community training<br>Collective memory and learning from past experiences |

Source: EEA.

Produced at a time when the European Union (EU) is re-positioning itself to bolster competitiveness, risk preparedness (including to risks posed by climate change and environmental degradation), and secure sustainable prosperity in an increasingly divided world, this report is a timely call to embed foresight in decision-making processes, and develop policy responses that embrace systemic and long-term thinking. Aimed at policymakers working across different levels of governance, experts in the four production and consumption systems as well as other societal actors looking for inspiration, the work intends to broaden understanding, stimulate debate and inspire action.

# 1 Introduction

*'If a world is dreamable, maybe it can be dreamed into being.'*

Ursula K. Le Guin

## 1.1 Imagining sustainable futures for Europe in 2050

It is widely recognised that in order to turn the European Union's (EU's) long-term vision of 'living well, within environmental limits' by 2050 (EU, 2013, 2022) into a reality, urgent and deeply transformative change needs to take place in how people perceive and interact with the natural world — humanity's 'life-support system'. In other words, fundamental, system-wide shifts in views (ways of seeing, thinking and knowing), structures (ways of organising, regulating and governing) and practices (ways of doing, behaving and relating) (IPBES, 2024) are crucial, with profound implications across all areas of society.

The European Green Deal (EC, 2019) acknowledges this need for transformation. It recognises the necessity to fundamentally transform the resource-intensive systems of production and consumption that both meet Europe's vital needs for energy, food, mobility and shelter (EC, 2019) as well as cumulatively drive climate and environmental pressures and impacts in Europe and across the globe. For this reason, the European Green Deal has set ambitious policy packages in motion to help the EU realise its long-term sustainability vision. These policies have far-reaching implications that extend across the environmental, social, cultural, economic and technological domains.

Broadly speaking, sustainability is about meeting the needs of the present generations without compromising the ability of future generations to meet their own needs (UN, 1987). However, what it means for core systems of production and consumption in a European context remains uncertain and highly contested.

Building a sustainable Europe is not an easy task, especially when faced with interconnected shocks and crises such as armed conflict, pandemics, inflation and increasing inequality. Climate change, pollution and biodiversity collapse present additional challenges that put pressure on life-sustaining systems, human health, economic prosperity and social welfare. Moreover, Europe's production and consumption systems are complex and constantly evolving, influenced by a set of interconnected drivers of change (EEA, 2020a). These include:

- a growing, urbanising and migrating global population;
- climate change and worldwide environmental degradation;
- increasing scarcity of and global competition for resources;

- accelerating technological change and convergence;
- power shifts in the global economy and geopolitical landscape;
- diversifying values, lifestyles and governance approaches.

In the face of turbulence and uncertainty, policymakers are increasingly turning to strategic foresight — the discipline of exploring and anticipating possible future developments to shape preferable futures — to foster a culture of preparedness and ensure policy responses are anchored in a long-term perspective (EC, 2025a; CoR, 2023; Monteiro and Dal Borgo, 2023). A number of publications and initiatives illustrate this effort at the EU level; these include the recently launched Preparedness Union Strategy, which aims to enhance Europe's capability to better anticipate, prevent, and respond to emerging threats (EC, 2025a); strategic foresight reports produced by the European Commission (EC) between 2020 and 2023 (EC, 2020a, 2021a, 2022, 2023a); the development of reference scenarios as a tool to improve decision making in a context of turbulence, uncertainty, novelty, and ambiguity (Vesnic Alujevic et al., 2023); the inclusion of strategic foresight in the EC's Better Regulation toolbox (EC, 2021b) (see Tool #20); and foresight studies published on topics such as bioeconomy (Borzacchiello et al., 2024), agriculture (EC, 2024) and the socio-economic impacts of the EU's transition to a climate-neutral economy (Eurofound and EEA, 2023). Equally, international organisations actively conduct foresight activities across multiple levels — corporate, regional, national and international. For example, the Food and Agriculture Organization (FAO) of the United Nations (UN) uses foresight to explore the futures of agrifood systems (FAO, 2022) and the UN Environment Programme (UNEP) uses foresight to look for emerging signals of change that can impact planetary health and human wellbeing (UNEP, 2024).

To acknowledge that a sustainable Europe could take very different forms, the European Environment Agency (EEA), in collaboration with its country network, the European Environment Information and Observation Network (Eionet), developed four distinct imagined futures or 'imaginaries'. These depict plausible and contrasting images of what a sustainable Europe could look like in 2050 (EEA, 2022a), intentionally excluding global developments which could influence the transition ([1]). The imaginaries, published in 2022, describe different governance approaches, socio-economic models, strategies and measures that could be deployed to achieve a sustainable Europe and help realise the UNs' sustainable development goals (SDGs), albeit reflecting different trade-offs between them. By highlighting new ways of thinking about how the future could unfold, the imaginaries are a valuable tool for forward-looking analysis and assessment that can support informed and responsible policy advice (see Box 1.1).

([1]) For more information on the method used to develop the imaginaries, click here.

## Box 1.1

**The imaginaries: a future-focused tool**

The EEA has used the imaginaries in multiple forward-looking analyses for a variety of reasons. These include:

- facilitating future dialogues on resilience for sustainability (EEA, 2024a);
- exploring different approaches to the circular economy in Europe (EEA, 2024b);
- encouraging thinking about what sustainable and resilient European cities could look like (EEA, 2024c);
- imagining the sustainable buildings systems of 2050 (EEA, 2024d);
- researching pathways to a resilient food sector in Europe through system dynamics modelling (Haraldsson et al., 2024);
- investigating multiple pathways and policy mixes for transforming European food systems (Lorenz et al., 2025).

The Joint Research Centre (JRC) has also used the imaginaries as a source to develop the four foresight scenarios that underpin the Science for Policy report (Matti et al., 2023) which, in turn, informed the EC's 2023 Strategic Foresight Report (EC, 2023a).

The imaginaries have also been used as a basis for 'Imagining a sustainable Finland in 2050' at a national workshop in October 2024. The workshop was organised by the Finnish Environment Institute; the Ministry of the Environment; the Prime Minister's Office; the Forum for Environmental Information and the Natural Resources Institute Finland (see Annex 1 for more details).

In this foresight report, the EEA uses the imaginaries of a sustainable Europe in 2050 (briefly described in Chapter 3) as four distinct lenses through which to explore what sustainable production and consumption systems — namely food, mobility, built environment and energy — could look like in the future. The report delves into the main characteristics of these four systems in 2050 and reflects on the interactions between them (see Chapter 4). It also examines how vulnerable the imaginaries are to future disruptions, both European and global (see Chapter 5). In addition, it highlights areas with the potential to transform core production and consumption systems towards sustainability and identifies a set of capacities that can harness such potential and help build resilience (see Chapter 6). Underpinned by seven participatory (online) workshops designed to foster creativity and harvest the collective intelligence of experts from science, industry, civil society and policy, the work is complemented by desk-based research and expert interviews — see Chapter 2 for more information on the methodology.

The report has been undertaken at a time in which the EU is re-positioning itself to regain competitiveness and secure sustainable prosperity in an increasingly divided world. It is a timely call to embed foresight in decision-making processes, and develop policy responses that embrace systemic and long-term thinking and consider the range of possibilities, challenges and opportunities inherent to the complex transformation of production and consumption systems towards sustainability. The work intends to inspire, stimulate debate and broaden understanding. It is aimed at policymakers across different levels of governance, experts in the four production and consumption systems and other societal actors seeking inspiration on ways to advance the transformation towards sustainability.

## 1.2 The value of imagining desirable futures

The unique challenges posed by the turbulence and uncertainty that characterise current times require creative ways of engaging with the future to bring about transformative change. Strengthening society's capacity for the collective imagination of desirable or preferred futures, while exploring alternative pathways towards these prospects, is the first step in creating a shared understanding as well as a commitment that can inspire deliberation and decision making toward sustainability.

Sustainability challenges are 'wicked' ([2]), in other words complex, multifaceted and resistant to straightforward solutions. To successfully navigate these sustainability challenges requires opportunities to bring together a wide range of knowledge, ways of knowing and perspectives that encourage shared understandings of the present and help envisage alternative futures that might include radical ideas never considered before. It also requires enabling institutional frameworks that link the consideration of desirable futures with decision-making processes (Cork et al., 2023).

Humans have been trying to imagine the future since ancient times. The transformative potential of foresight approaches arises precisely from their ability to harness this innate human capacity to imagine futures that do not yet exist (Preiser et al., 2024). Observing or experiencing novel modes of being or acting can, in turn, spark new imaginative potentials (Raudsepp-Hearne et al., 2020). These sparks of potential can ignite new ways of thinking about how the future could develop. Transcending the constraints of dominant narratives will help expand the range of available ideas and options for action.

The exploration of desirable futures serves several functions. Firstly, it represents the crucial initial step towards sustainability planning and coordination, as well as towards the associated policy measures. To transform society, it is essential to examine the complex connections that exist between different system dimensions and envision what that society could look like (Vervoort et al., 2024).

When it comes to transforming different areas of society, systemic interactions make future development pathways extremely uncertain. It is therefore essential to think in terms of alternative futures, as highlighted by the EEA and Eionet's work on imagining sustainable futures for Europe in 2050 (EEA, 2022a).

Dialogue around possible futures facilitates social learning through the exchange of assumptions, expertise and worldviews, while also enhancing awareness of the diverse interpretations of reality. In this way, the exploration of desirable futures promotes forward-thinking decisions and encourages collective responsibility to avert future harm.

([2]) The term 'wicked problem', originally developed in the field of urban planning (Rittel and Webber, 1973), gained traction in sustainability studies as a realistic description of governance problems. One of its main features is that there is no consensus on how to frame the problem and what counts as a solution — more knowledge about the problem does not necessarily translate into knowledge about how to solve it.

One of the greatest challenges regarding sustainability transformations is the complex human responses associated with climate change and ecological breakdown. These include cognitive, emotional and affective reactions to scientific projections, climate justice, the loss of ecosystems and cultures and the potential breakdown of societies (Hamilton, 2020). Emotional reactions include phenomena such as eco-anxiety and climate anxiety (Cunsolo et al., 2020) that are characterised by emotions ranging from fear, worry and anxiety to helplessness, dread, horror and even panic and hysteria (Pihkala, 2022). It also involves responses such as denial, anger and resignation (Lertzman, 2015), as well as grief and guilt (Cunsolo et al., 2020). Climate- and eco-anxiety thus encompass multiple emotional dimensions that can cause feelings of paralysis or resignation (Clayton and Karazsia, 2020). By demonstrating that sustainability transformations are feasible and by offering concrete vivid, hopeful and bold stories of what a sustainable future might look like, envisaged desirable futures help sustain optimism and generate collective agency. They also provide inspiration for decision-makers to take action towards sustainability.

The alternative sustainable futures for European core production and systems presented in this report aim to support the pursuit of alternative pathways to current socio-ecological trajectories. They also seek to encourage transformations toward sustainability.

### 1.3 Report structure

The report is organised in six chapters (see Figure 1.1).

**Chapter 1: Introduction**, presents the rationale and aims of the work.

**Chapter 2: Methodology**, outlines the methodology used to:

- explore what sustainable production and consumption systems — food, mobility, built environment and energy — could look like in 2050;
- examine how disruptive events (European and global) could impact the four imaginaries; and
- identify areas of transformative potential within each system as well as capacities that can harness such potential and foster resilience.

**Chapter 3: Imaginaries of a sustainable Europe in 2050**, provides an overview of the four imaginaries published by the EEA in 2022, including descriptions of their key drivers, core assumptions, pivotal actors and governance mechanisms.

**Chapter 4: Exploring the future of core production-consumption systems**, describes what sustainable production and consumption systems — food, mobility, built environment, energy — look like in each of the four imaginaries. For each system it summarises:

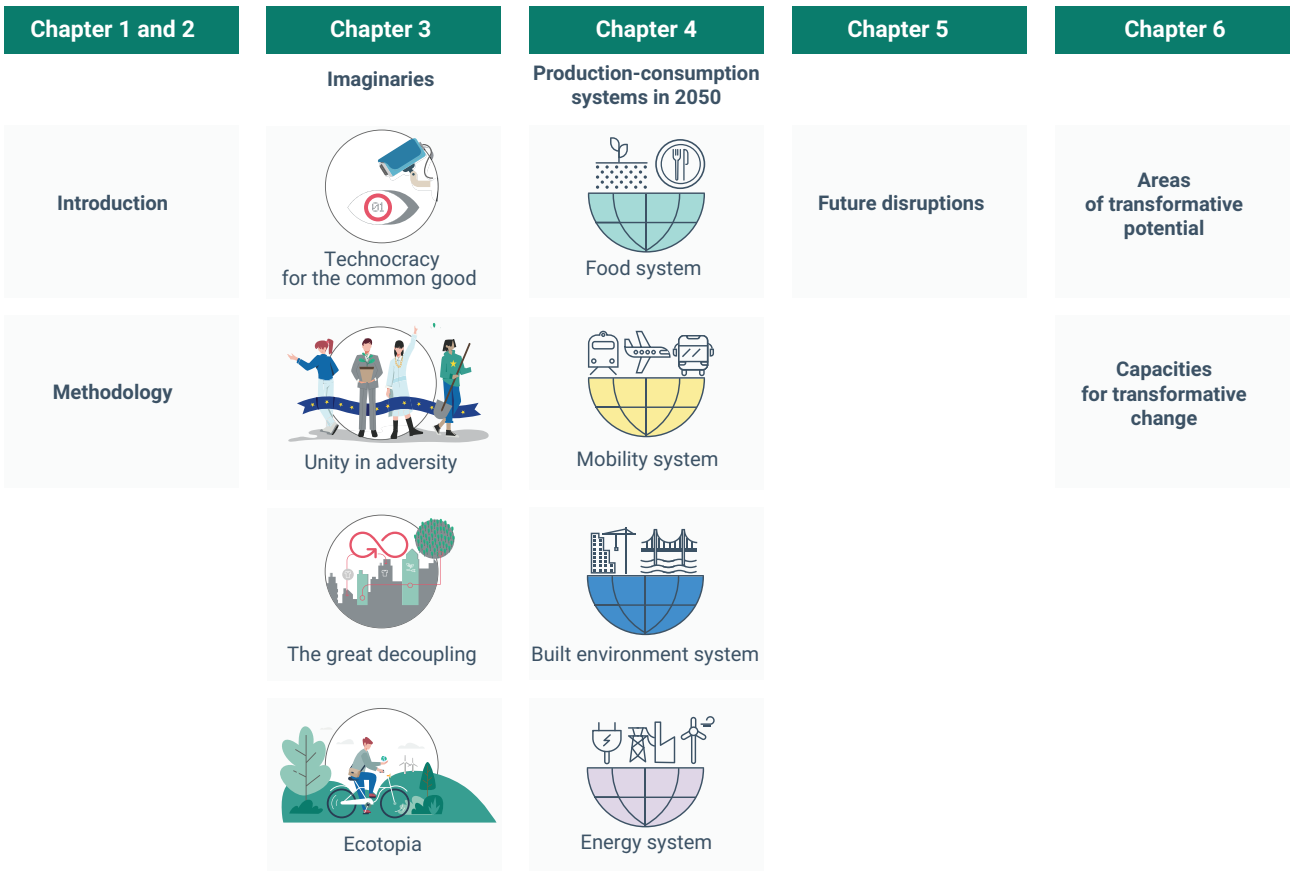
- the main characteristics of the system today;
- the system in 2050, in terms of:
  - production;
  - consumption;
  - ensuring access to system products and services.

Building on this, the chapter also outlines the patterns of change that emerge per system across the imaginaries, as well as key cross-system interconnections.

**Chapter 5: Imagining sustainable futures in the light of future disruptions**, examines the vulnerabilities of the imaginaries to future disruptions (European and global).

**Chapter 6: Towards a sustainable future**, outlines areas where actions have the potential to transform core production and consumption systems towards sustainability and a set of capacities that can harness such transformative potential and foster resilience.

**Figure 1.1** **Report structure**




**Source:** EEA.

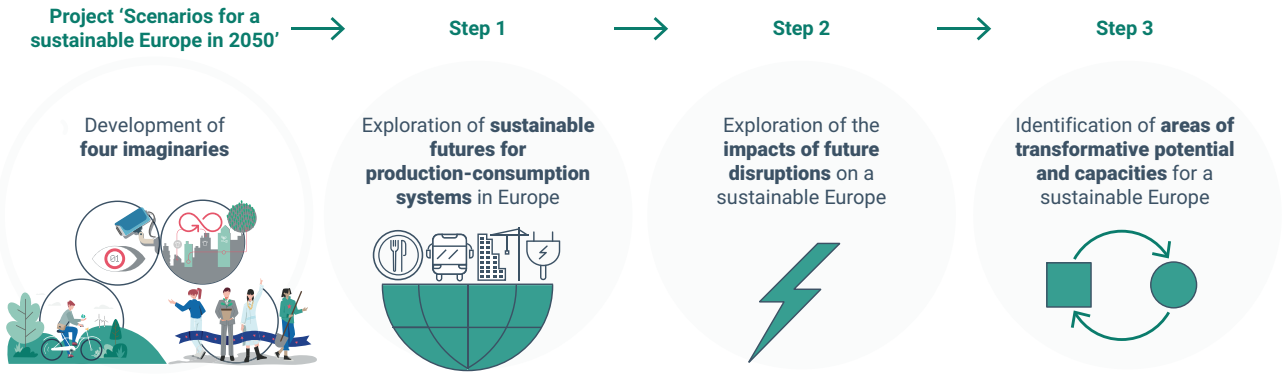
# 2 Methodology

This chapter presents the methodology used in this foresight report. The process spanned from March 2022 to December 2024. It incorporated desk-based research, participatory workshops ([3]), in-depth analysis and expert interviews to produce knowledge that can support and inspire policymakers and other societal actors working to advance the transformation towards sustainability.

The chapter is structured according to the three main steps of the project, with each step building on the results of the previous one(s) (see Figure 2.1):

- **Step 1:** Exploration of sustainable futures for production and consumption systems in Europe (i.e. food, mobility, built environment and energy) using the imaginaries as four distinct lenses.
- **Step 2:** Exploration of the impacts of future disruptions (European and global) on a sustainable Europe, using the imaginaries as four distinct lenses.
- **Step 3:** Identification of areas of transformative potential within each production and consumption system and of capacities that can harness such transformative potential and foster resilience.

**Figure 2.1** **Steps of the project**




Source: EEA.

([3]) To view the guiding questions addressed at the participatory workshops, see Annex 2.

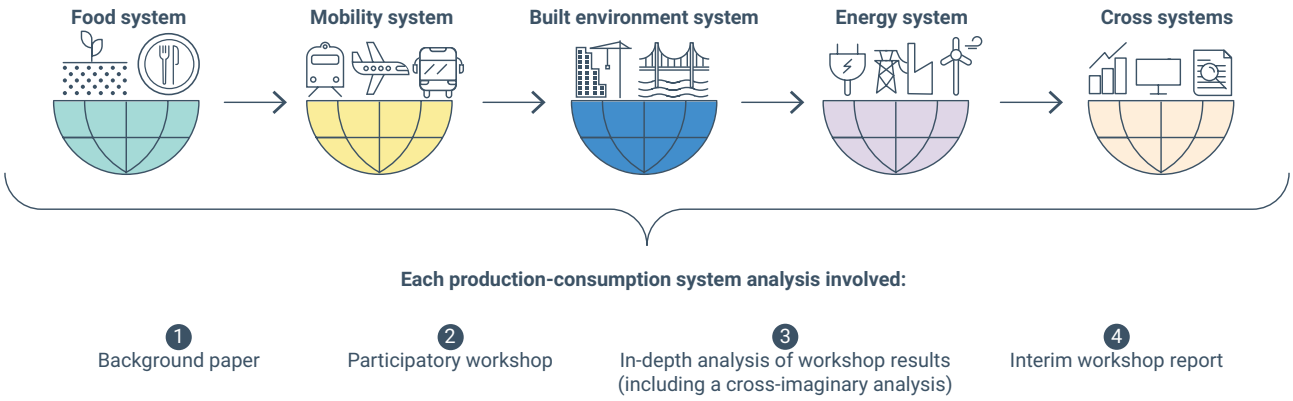
## 2.1 Step 1: Exploration of sustainable futures for production- consumption systems in Europe

This step explored what the future of core production and consumption systems — food, mobility, energy and built environment — could look like according to the logic of the four imaginaries of a sustainable Europe in 2050. It also explored cross-system interconnections — both synergies and tensions — within each imaginary.

### *The process in detail*

This exploration was underpinned by a series of five four-hour online participatory workshops, each held with about 30 selected experts from academia, civil society, industry and government organisations (national, EU and international). Each workshop was supported by a background paper containing specific guiding questions (see Annex 2), an overview of the imaginaries and a concise description of the production and consumption system in question, based on a literature review. In the cross-systems workshop this was replaced by the preliminary results of the four preceding workshops (see Figure 2.2).

**Figure 2.2 Overview of step 1**




**Source:** EEA.

## 2.2 Step 2: Exploration of the impacts of future disruptions on a sustainable Europe

This step explored how future disruptions could impact a sustainable Europe in 2050, through the lenses of the imaginaries. Here, a future disruption refers to a plausible extreme development in Europe or worldwide that could, if it came about, significantly alter the policy landscape. This step brought the global dimension into the picture and enabled a reflection around the vulnerabilities present in each imaginary and also the identification of critical response capacities that can help build resilience for sustainability in Europe. In this context, future disruptions (European and global) were used as a tool to stress-test this set of four plausible sustainable futures and generate anticipatory knowledge that can cultivate preparedness.

### *The process in detail*

As part of this step, a literature review and analysis were carried out to identify and characterise suitable future disruptions that could challenge the storylines of the imaginaries. Out of an initial set of 26 future disruptions, covering the social, technological, economic, environmental (including health) and political domains (STEEP), three disruptions per imaginary were selected for exploration at the workshop (see Annex 3).

The exploration of the impacts of future disruptions was based on a four-hour online participatory workshop, held with approximately 30 participants, this time also including experts in risk management and from the insurance sector. The workshop was supported by a background paper containing specific guiding questions (see Annex 2), an overview of the imaginaries and a concise description of the future disruptions to be addressed.

## 2.3 Step 3: Identification of areas of transformative potential and capacities for transformative change

The final step included a final analysis to identify areas of transformative potential across the four production and consumption systems, based on the previous explorations of the imaginaries. These areas, albeit non-exhaustive, outline where actions might be focused today to facilitate or catalyse system changes towards a sustainable Europe in 2050. These areas of transformative potential are accompanied by a set of capacities that can be fostered to both:

1) facilitate the transformation of European consumption and production systems towards sustainability and

2) develop societal resilience to help European societies weather the storms of disruptive events.

The step included an in-depth analysis of the results of the previous steps, complemented by expert interviews on specific topics.

# 3 Imaginaries of a sustainable Europe in 2050

This chapter presents enriched versions of the four imaginaries developed by the EEA in 2022 (EEA, 2022a) that offer additional insights on key economic, technological and social characteristics that together build a picture of what sustainability looks like in each of these four futures. Figure 3.1 provides an overview of the core narrative of each imaginary while Table 3.1 summarises the imaginaries' main characteristics in terms of key drivers of change, core assumptions, pivotal actors and governance mechanisms.

**Figure 3.1** **Overview of the core narrative of each imaginary**


**1**

In '**Technocracy for the common good**', sustainability is achieved through state control at the national level, which prioritises society's collective interests. Information and communication technologies enable unprecedented monitoring and control of social and ecological systems.

**2**

In '**The great decoupling**', innovative companies are the central actors. They succeed thanks to technological breakthroughs, especially in the bioeconomy, enabling the decoupling of gross domestic product (GDP) growth from adverse environmental impacts.

**3**

In '**Ecotopia**', stakeholders from civil society have brought about a shift in collective thinking and action. Local communities reconnect to nature while technology is used sparingly to enable sustainable lifestyles. Consumption and resource use are being scaled back markedly.

**4**

In '**Unity in adversity**', Europeans respond to severe environmental, climate and economic crises by empowering the EU to use stringent, top-down regulatory and market-based measures to set rigorously enforced boundaries for economic activity.

**Source:** EEA, adapted from EEA, 2022a.

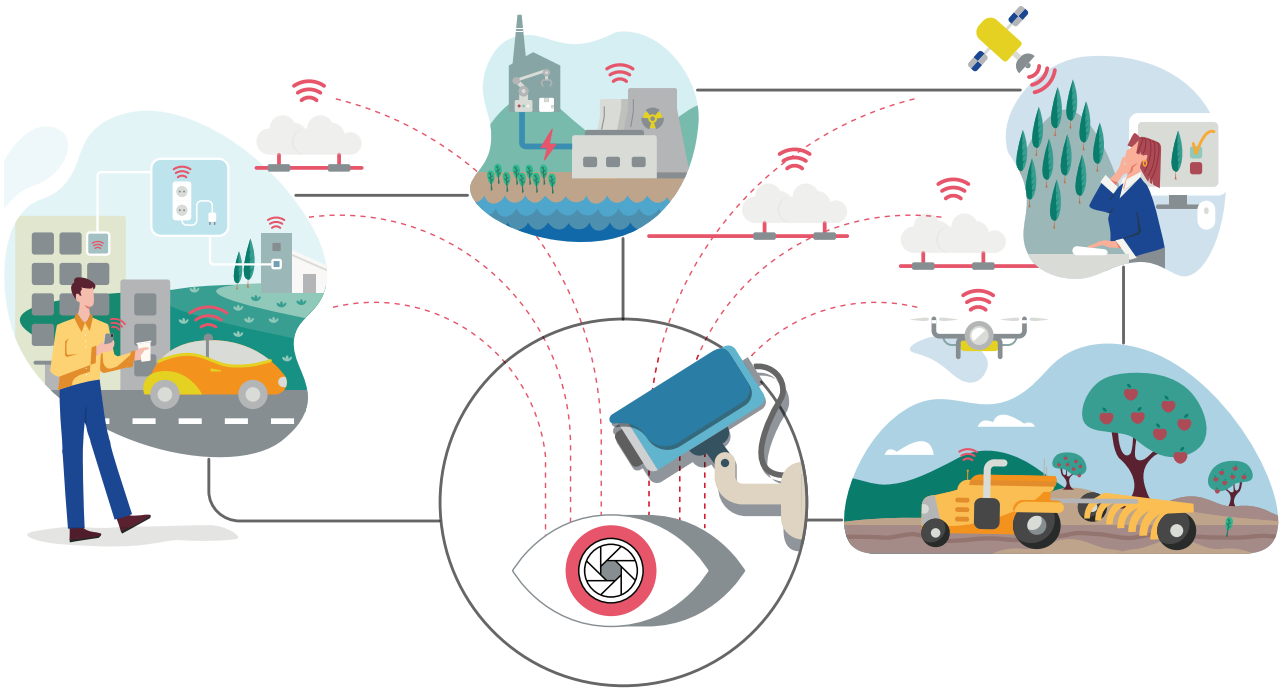
**Table 3.1 Summary of the main characteristics of each imaginary**

| Imaginary | Key drivers | Core assumptions | Pivotal actors | Governance mechanisms |
|---|---|---|---|---|
| **Technocracy for the common good**  | Decades of persistent social and environmental problems, blamed on liberalised markets, made Europeans turn to the state for solutions. | The functionality and stability of digital operations rely on resilient systems, effective data sharing and secure artificial intelligence (AI) deployment, while state governance relies on strong top-down regulatory frameworks and instruments. Positive citizen-government relations depend on acceptance of rules and a commitment to social equity. | National governments drive sustainability transformations, supported by a strong digital industry, knowledge brokers and a powerful financial sector. | State governance and administration are largely top-down, digital and based on real-time data in all areas, including all production and consumption systems. |
| **Unity in adversity**  | Recurrent environmental and climate disasters, geopolitical tensions and financial shocks pushed Member States to join forces to form a strong federal EU. | A commitment to solidarity emphasises inter-regional support for resource distribution and aims to reduce wealth disparities while enhancing social equity. | An authoritative EU exercises its governance through an empowered European Parliament, European Commission, and other agencies, while industry plays a subservient role to national governments that execute EU policy and regulations. | The EU has a common constitution and uses stringent regulations and economic instructments to promote economic activity within strict environmental limits. Taxation is a powerful mode of incentivising innovation and markets, ensuring territorial cohesion. |
| **The great decoupling**  | Breakthroughs in technological and social innovations enabled an extraordinary decoupling of economic growth from environmental harm, with resource efficiency, circularity principles, biotechnological advances and a thriving bioeconomy at the centre. | Sustainable yet consumption-oriented lifestyles rely on the affordability of consumption, social and political stability, alongside trust in markets. | Businesses in competitive, liberalised markets play a central role in enabling green growth within environmental limits. | Governments typically rely on the invisible hand of the market to harmonise the interests of companies and society and intervene to shape market incentives, correct market failures and drive forward innovation. |
| **Ecotopia**  | The confluence of climate change, growth scepticism, government distrust and the desire to live in harmony with nature unravelled a deep transformation that replaced profit maximisation and consumerism with values of sufficiency, equity and respect for nature. | Nature has an intrinsic value and deserves protection rather than being seen merely as a resource for human use. Power is decentralised to local civil actors who can effectively address community needs, fostering a strong community spirit and a focus on reducing inequality. | Empowered local communities and civil society organisations, including youth, play a central role in decentralised participatory governance. | Decentralised and participatory governance structures support stakeholder-driven local and regional solutions, that value experimentation. Businesses are stakeholder-led. |

**Source:** EEA.

## 3.1 Technocracy for the common good

**Figure 3.2** **Illustration of the imaginary *Technocracy for the common good***



**Source:** EEA, 2022a.

### *Key drivers*

After decades of persistent and growing social and environmental problems, which many blamed on liberalised markets, Europeans have increasingly turned to powerful central states for solutions. At the same time, advanced information and communication technologies and other high-tech innovations have enabled unprecedented monitoring of ecological, social and economic systems and more efficient use of materials. On this fertile ground, EU's nation states have expanded their remit to drive their societies towards sustainability through digital governance.

### *Core assumptions*

National governments use top-down regulatory frameworks and instruments as well as advanced information and communication technologies to enable unprecedented monitoring of ecological, social and economic systems. The functionality and stability of digital operations rely on resilient systems, effective data sharing and secure AI deployment. At the same time, positive citizen-government relations depend on acceptance of rules, effective nudging for behaviour change and a commitment to democratic governance and social equity. Together, these elements create a robust framework for a well-functioning society.

### *Pivotal actors*

By 2050, EU Member States differ substantially in their approaches to regulating personal life. Confronted with 'exit threats', the EU devolved some powers to Member States and was cut back to a well-functioning partnership among strong national governments leaning towards de-globalisation and protectionism. National and local governments are key actors in a multi-level-governance practice that connects citizens to responsive and proactive policy and digital administration. Governments exert substantial influence over the large businesses that dominate the centralised economic activities. The digital industry and related intermediaries are critical actors across all production and consumption systems. Other important actor groups include the finance industry diplomats and powerful thought leaders in the knowledge society.

### *Governance mechanisms*

Europe has achieved high living standards and healthy ecosystems through meticulous, data-intensive, top-down steering of the economy and society. National governments prioritise society's collective interests and play a strong role in organising production and consumption through regulation, market design and taxation. Digitalisation enables unprecedented monitoring and control of social and ecological systems using real time in-situ data. The digital linkage of production and consumption systems, such as food, mobility, energy and the built environment, has enabled a system-of-systems governance approach. This accounts for multiple sustainability goals, inter-system synergies and trade-offs and also ensures supply meets demand efficiently and equitably.

## 3.2 Unity in adversity

**Figure 3.3** **Illustration of the imaginary *Unity in adversity***

**Source:** EEA, 2022a.

### *Key drivers*

Recurrent environmental and climate disasters, geopolitical insecurity and financial shocks have had devastating impacts in Europe. These include both shorter-term events like deadly heat waves, floods, wildfires and severe storms as well as longer-term changes like droughts, increases in zoonotic diseases, decreased biodiversity and ecosystem loss. The associated social and economic damages and crises inflict additional hardships on human societies, pressing European nations to their limits. In response to these compounding crises, Member States rally in support of a strong, federated EU — forgoing many aspects of sovereignty in pursuit of a stable, liveable and sustainable EU.

### *Core assumptions*

Strong and coordinated governance at the EU level is characterised by an active European Parliament, powerful institutions and a central role for the European Central Bank, fostering trust and community participation. A commitment to solidarity emphasises inter-regional support for resource distribution and aims to reduce wealth disparities while enhancing social equity. Additionally, a highly regulated yet functional economic system ensures business compliance with EU directives, prioritises environmental concerns, maintains job availability and promotes innovation aligned with socio-ecological goals in a less consumeristic society.

### *Pivotal actors*

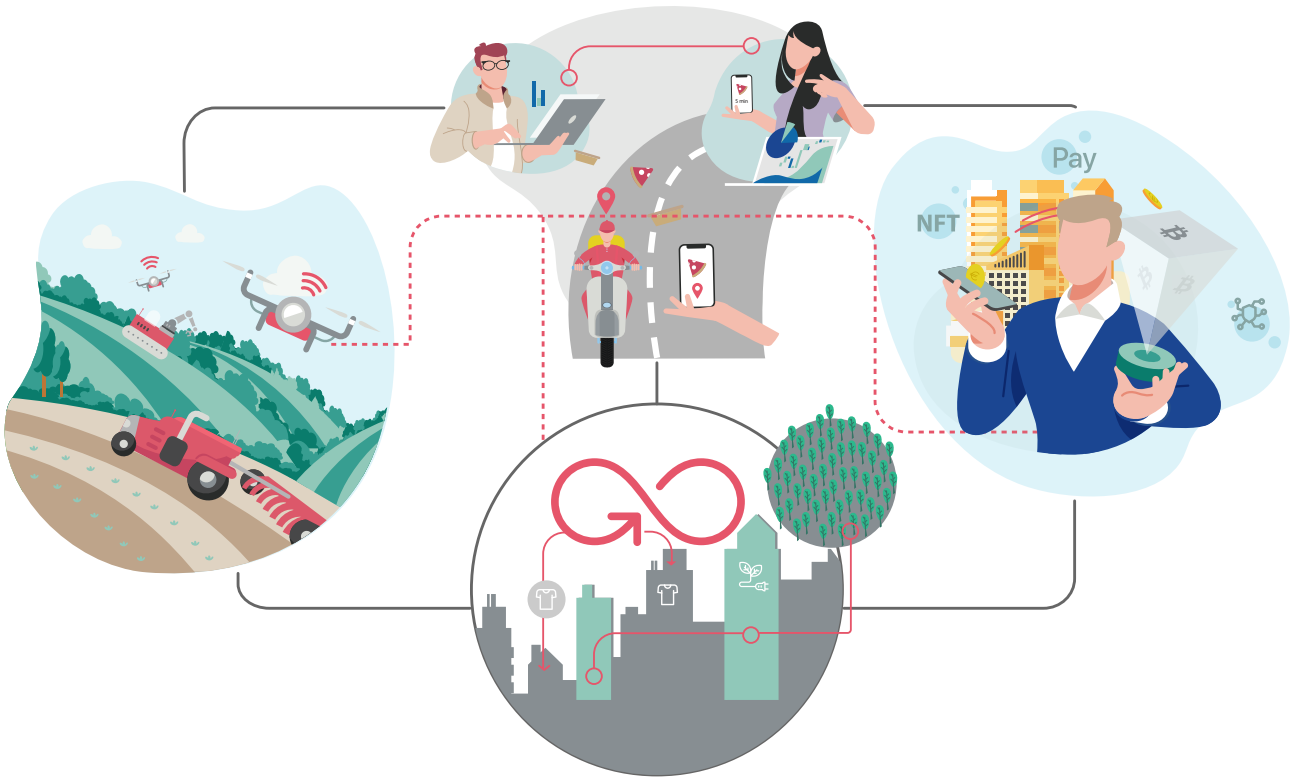
The European institutions wield incredible power to set and enforce policies to ensure political and economic integration within strict environmental limits. The European Parliament uses potent governance instruments to ensure political and economic integration within strict environmental limits. State governments adhere to EU authority and pursue stringently constrained economic growth. The European Central Bank exerts strong control over the EU's markets and monetary supply and businesses are heavily taxed, particularly for large multinationals and tech companies. EU-level taxation balances regional inequalities and helps ensure access to basic goods and services. However, it also creates barriers for European businesses to operate in external markets. Local governments are also empowered actors in the implementation and maintenance of food, energy, mobility and infrastructure projects within their boundaries.

### *Governance mechanisms*

The strong, top-down model of governance by the European Parliament and the EU's executive branches is in firm control of all aspects of the EU's socio-economic and environmental activities. The European Commission, assisted by European agencies, exercises its authority through strict regulations and standards that are applied and enforced across the EU, with the European Parliament serving as a key forum for negotiations between differing national and regional interests. In all matters and decisions, the protection and restoration of the EU's natural environment has been granted priority status. This is equalled only by the EU's commitment to ensuring a stable quality of life for all.

## 3.3 The great decoupling

**Figure 3.4** **Illustration of the imaginary *The great decoupling***




**Source:** EEA, 2022a.

### *Key drivers*

Economic growth and the desire for technological sovereignty encourages heavy investment in research and innovation (R&I) to transform Europe's core production and consumption systems. Breakthroughs in technological and social innovations, due in part to resource security and demographic concerns, enabled an extraordinary decoupling of economic growth from environmental harm. At the centre of this change are resource efficiency and circularity principles, biotechnological advances and a thriving bioeconomy sector spanning energy, food and material production. Robotics, automation and Artificial intelligence (AI) are thriving. Society has largely adopted 'green' lifestyles and rewards creativity, flexibility and mobility.

### *Core assumptions*

Sustainable yet consumption-oriented lifestyles rely on the affordability of consumption as well as social and political stability, alongside trust in markets. The success of AI and biotechnological innovations in a knowledge-intensive economy hinges on the availability of skilled workers, necessitating an efficient education system and talent mobility. Additionally, the critical supply of (raw or secondary) materials essential for a booming economy underscores the dependence on globalisation, secured by geopolitical alliances.

### *Pivotal actors*

Key actor groups include the technical industry, encompassing biotech firms, multinational corporations and influencers within innovation ecosystems, states that possess critical raw materials along with entrepreneurs from the global south and AI algorithm developers. Businesses in competitive, liberalised markets play a central role in the development and operations of production and consumption systems, with governments responding to correct market failures and promoting the emergence of disruptive innovations and entrepreneurship. Additionally, high-skilled knowledge workers, educational institutions and research organisations play a significant role, as do financial governance actors.

### *Governance mechanisms*

Governments focus on securing the framework conditions for liberal markets, promoting research and innovation (R&I) and restricting the power of monopolies and giant global companies. EU-wide coordination is only necessary in a few areas in which European companies are global leaders, such as in biomedical nanorobotics, pharmaceuticals or tissue engineering. Following the liberal ethos, policy aims for equality of opportunity rather than equality of outcome. Growth means that governments have resources to fund unemployment benefits, retraining, or fiscal transfers to households in need.

## 3.4 Ecotopia

**Figure 3.5 Illustration of the imaginary *Ecotopia***


Source: EEA, 2022a.

### *Key drivers*

The confluence of climate change impacts, deep scepticism about market-driven economic models and governments' ability to fight climate change, coupled with the desire of the younger generations to live in harmony with nature created the conditions suitable for a profound societal transformation. This transformation replaced profit maximisation and consumerism with values of sufficiency, equity and respect for nature. European populations have dispersed in search of communities of practice that reflect commitments to slow living and reduced environmental impact. Economic activities and sectors are fragmented and localised, with deglobalisation and local supply chains dominating Europe's production and consumption system landscape.

### *Core assumptions*

Nature has an intrinsic value and deserves protection and respect, rather than being seen merely a resource for human use. Power is decentralised to local civil actors who can effectively address community needs. This fosters a strong sense of community responsibility and a focus on reducing inequality. A fundamental shift in consumption habits towards sufficiency and responsibility, recognises humanity's integral role in the ecosystem. It also advocates for a transformative understanding of knowledge that encourages continuous societal evolution, collective decision-making and the establishment of inclusive education and healthcare systems.

### *Pivotal actors*

Key actors include civil society, driven by grassroots movements and non-governmental organisations (NGOs) advocating for sustainability and community initiatives. Local actors consist of individuals and groups actively participating in decision-making and implementing sustainable practices. The EU persists but operates with relative weakness, with Member States forming flexible coalitions to address specific policy areas. Decentralised networks of empowered local communities are central in shaping collective action to provide social care and support for health, education and self-sufficiency.

### *Governance mechanisms*

Social, economic and political systems are decentralised. Public policies are debated and adopted with citizen involvement. Experimentation in governance is widespread, with the lessons learned shared and discussed on social media and in public spaces. Businesses are often managed by stakeholders, including customers, employees and local communities. The EU is relatively weak, with Member States collaborating in 'coalitions of the willing' to tackle policy areas such as defence or taxation, where citizens have a strong voice.

# 4 Exploring the future of core production-consumption systems

This chapter describes what sustainable production and consumption systems — food, mobility, built environment and energy — look like in each of the four imaginaries of 2050, based on the outcomes of the participatory workshops. For each system, it summarises:

- the main characteristics of the system today;
- the system in 2050, in terms of:
  - production;
  - consumption;
  - ensuring access to system products and services.

The imaginary-specific system descriptions are followed by a brief comparative analysis of the patterns of change that emerge per system across the four imaginaries, including challenges and opportunities.

The chapter ends with a brief cross-system analysis that highlights key interlinkages and interdependencies between the different systems and the importance of adopting a systemic and coordinated approach to decision-making.

## 4.1 Food system

A food system can be defined as 'all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food and to the outputs of those activities, including socio-economic and environmental outcomes' (HLPE, 2014) (see Figure 4.1). Food systems are inherently multifunctional, multi actor and deliver a complex and interconnected set of desired social, environmental and economic outcomes, such as food and nutrition security, social well-being and ecosystem health (EEA, 2017, 2019). Food systems shape our landscapes, economies, communities and cultures and are deeply intertwined with other systems, in particular the health, mobility and energy systems.

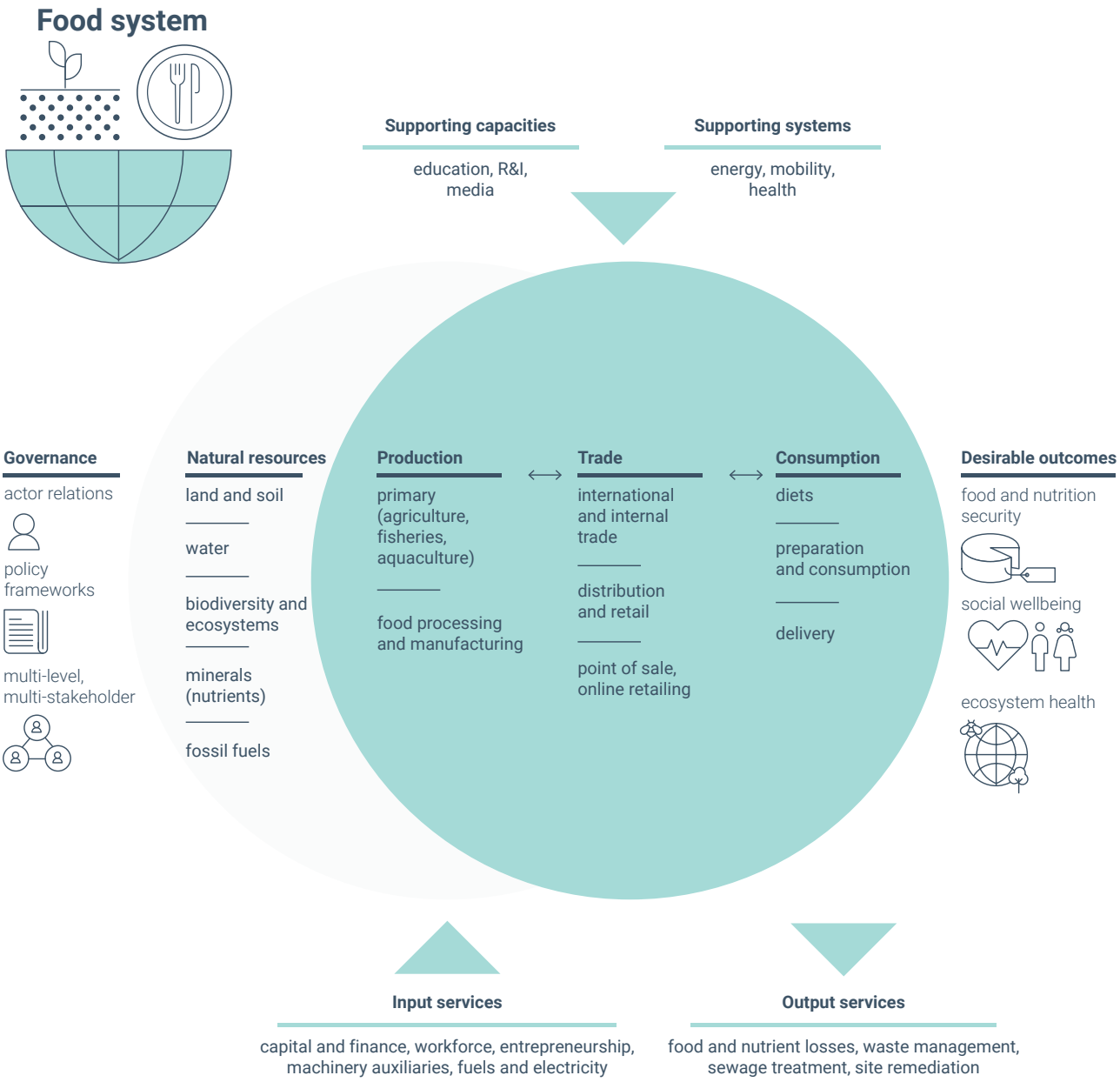
Food systems depend on the state of the environment and climate. They are also responsible for a third of global greenhouse gas (GHG) emissions (Crippa et al., 2021), as well as loss of biodiversity and ecosystem degradation (Benton, 2021), and impacts on human health. These human health impacts include malnutrition, diet-related obesity and diet-related non-communicable diseases (Willett et al., 2019). Food systems also play a role in social injustices and power imbalances (EEA, 2017; IPES-Food, 2019; SAPEA, 2020). Urgently transforming today's food system is therefore a cornerstone for sustainability in Europe and worldwide (IPES-Food, 2019; Willett et al., 2019; SAM, 2020; SAPEA, 2020;

Bock et al., 2022). This ambition is reflected in the EU's farm to fork strategy, which aims to enable and accelerate the transition to a fair, healthy and environmentally friendly food system (EC, 2021c). The European Commission's (EC) new roadmap for agriculture and food policy, the 'Vision for Agriculture and Food' (EC, 2025b), highlights the strategic importance of the agri-food sector for the EU over the period 2025-2030 and beyond. It also sets the stage for strengthening its long-term competitiveness, attractiveness and resilience for current and future generations.

Europe's food system is constantly evolving and is shaped by numerous trends, often pulling in different directions. These trends include: the surge of alternative proteins and plant-based diets; the erosion of traditional food cultures; the rise of personalised health; novel foods and new forms of food production; consumer-producer initiatives; increased focus on the bioeconomy, traceability of products and extreme weather events.

Cover photo: © Anna Pelzer, Unsplash

**Figure 4.1** **Map of the contemporary food system**




**Notes:** This system diagram was used at the food system workshop as a starting point for exploring how the system might change and look like in the four imaginaries of 2050.

R&I, research and innovation.

**Source:** EEA.

The following sections describe what a sustainable European food system could look like in 2050 through the lenses of the four imaginaries in terms of production, consumption and ensuring access to system products and services.

### 4.1.1 Technocracy for the common good

#### Food production in 2050

National governments monitor and control all dimensions of the food system using digital tools. They also exert a strong influence over the large companies that operate the food value chain — from primary production and food manufacturing, to wholesale and retail. Sustainable intensification is the dominant paradigm (even within agroecology and organic farming). Agriculture is carried out to exploit maximum sustainable yields, using advanced sensor networks and AI-based optimisation, from field-level to operations management. Precision-design (including genetic modifications of conventional and ancient grains) adapts seeds to regional soil and climate conditions. These are then cultivated by precision farming, supported by agri-drones and agri-bots that replace heavy machinery. Whilst fishing and conventional aquaculture have dwindled, novel sea value chains — such as seaweed, algae and jellyfish — and closed-loop aquaculture have gained importance. A share of food production is relocated to smart cities that integrate food production and distribution in their planning and infrastructure, for example, vertical farming is a prerequisite in spatial planning. Sustainable food innovations are typically developed in the R&I labs of large food companies and are then immediately patented. Sustainable food innovation attracts skilled employees to the R&I intensive bio-labs and bio-factories situated in cities. Food policy is often interlinked with other land use, energy and industrial policies, for example through agroforestry, agrivoltaics (the use of land for both food and solar photovoltaic energy generation) and the bioeconomy.

#### Food consumption in 2050

National governments use dynamic food pricing to translate the health and environmental costs of nutrition into actual food prices and thus nudge the consumer towards healthier dietary choices. People eat proteins produced by cellular agriculture, which is the process of producing animal-based foods and other products directly from animal cells. Proteins are also consumed from bio-fermentation, which is the extraction of proteins from biobased residual resources. In contrast, animal-based nutrition is marginal. The nutritious value and healthiness of diets are prioritised over taste and food culture. Personalised nutrition is part of an individualised digital health regime that provides strong incentives for healthy food consumption patterns.

#### Ensuring access to sufficient, safe, nutritious and healthy food

States prioritise food-related health and environmental aspects over individual preferences. Digitally implemented dynamic and individual food pricing is a means to provide effective monetary incentives for healthy, sustainable diets. It also guarantees that individuals and families can always afford to purchase healthy food based on their financial situation.

Populations across Europe increasingly consume nutritious and healthy food produced in bulk at bio-refineries. Eating exotic food is now a celebrated ritual for those who can afford it. The expenditure share of individuals for food increased due to the internalisation of external costs of food. National governments control food shortages through digital recognition and reallocate wealth to improve access to nutritious and healthy food for the poor.

### 4.1.2 Unity in adversity

#### Food production in 2050

All food production is orchestrated by the EU and local authorities to limit environmental impacts and facilitate ecosystem regeneration. These joint efforts include funding mechanisms that enhance agricultural output and mitigate natural hazards in the pursuit of environmental goals and resilient food sources. In rural areas, the integration of agriculture and nature (e.g. agroforests) promotes the role of ecosystem services for regulating and supporting primary production. Additionally, soil management practices foster biodiversity and nutrient cycling, soil formation, carbon sequestration and primary food production. New technologies and integrated approaches to food production are of crucial importance, particularly in areas with labour shortages. These include the use of low methane livestock diets and indoor methane capture. The use of autonomous agriculture drones capable of organic, precision farming in difficult terrains and integrated polyculture farming operations are also included. Additionally, the development of novel sea agriculture value chains promotes the availability of new protein sources. The production of artificial meat and other synthetic food substitutes has increased to industrial scale, supporting food security and accessibility. These technologies are highly regulated and controlled by European institutions monitoring food safety, environmental impacts, resource allocation as well as responsible and ethical research and production.

#### Food consumption in 2050

A large proportion of the food consumed is produced in Europe, with a strong focus on ensuring food security both regionally and across the EU. This shift, in combination with environmental and resource regulations, results in more seasonal diets. It also results in a reliance on fermented products and limited consumption of imported food products. Alternative proteins like insects, algae, artificial meat and plant-based dairy alternatives are subsidised and play a major role in guaranteeing nutrition availability. Personalised and functional nutrition is enabled through individual-based health and wellness monitoring systems. At the societal level, dietary choices are influenced by a broader culture shift and policy instruments (such as taxes, subsidies and carbon pricing), favouring organic, low-carbon, locally-sourced products. There is very little food waste from across the value chain, with incentives to limit waste both in processing and retail.

#### Ensuring access to sufficient, safe, nutritious and healthy food

Availability and access to food is paramount and focus is directed on the development and strengthening of a more regionalised, secure supply chain at the European level, including multiple risk management instruments. Strong European governance structures allow for the creation and maintenance of public reserves for times of crisis, with a strong focus on ensuring a high level of local self-sufficiency and a successful response to inequalities. At the same time, EU policies incentivise people to live in rural areas, creating populations in closer proximity to food sources. This makes labour pools more robust and lowers the environmental impacts of food distribution.

### 4.1.3 The great decoupling

#### Food production in 2050

The agricultural sector is part of a highly efficient, circular bioeconomy that is dominated by multinational biotechnology companies. These companies cultivate huge land areas using proprietary products and deploy precision agriculture.

Technology-enabled productivity gains and organic farming play an important role in environmental protection. Agriculture is used for carbon sequestration with benefits to soil health and biodiversity. Advanced digital systems are present across the food value chain. The large multinationals also control much of the industrial production in the food system that is globally distributed, with many hubs across Europe. Localised processing units are networked with local suppliers as franchises and draw from localised agriculture operations. Europe's urban regions contribute to food systems with cellular production, indoor aquaponics and vertical farming on building facades. In addition, large-scale aquaculture is being used for food production processes in most European waters. There is fierce global competition for scarce resources across all production systems, especially for water and minerals needed in the food production system.

#### *Food consumption in 2050*

While there is enough food available, there is a trend towards less healthy food as nutritional standards are lowered for various reasons. Policies promote the internalisation of environmental externalities and create pricing incentives that shift dietary choices away from emissions-intense animal products. Artificial meat has been developed on an industrial level; wild-caught meat is severely limited and there are other alternative and cheaper sources of protein for consumers, such as insects, pulses, algae and eggs. An increasing amount of people are eating lab-grown superfood products, of which composition is customised and marketed. Due to a strong market orientation, standards, monitoring and control systems are seldomly regulated by the state and are only harmonised across Europe in particularly critical areas.

#### *Ensuring access to sufficient, safe, nutritious and healthy food*

Market forces are trusted to ensure the affordability and accessibility of quality food with large multinationals translating government funding and incentives into innovations across the food system. While food inequalities exist, food safety depends on the availability of resources, access to products and markets and the affordability of products. This is hampered worldwide by numerous disasters and extreme weather events as well as regional differences in production. In the event of food availability crises, political solidarity measures coordinated across European nations ensure that emergency aid maintains an adequate food supply to European communities in need.

### *4.1.4 Ecotopia*

#### *Food production in 2050*

Food production has shifted to closed-loop systems on small-scale, cooperative farms and to urban areas that prioritise integration with natural systems. Organic farming and agroecology using virtually no chemical fertilisers and pesticides are the primary food production methods with digital innovations, including precision farming, agri-drones, agro-robots and agrivoltaics, facilitating resource-efficient food production. Overall, agrobiodiversity has increased. Local genetic diversity of plants and seeds is used as a form of adaptation to new climatic conditions. Agricultural technology is often collectively utilised by communities, which also explore creative solutions for local food production through community gardens, urban farming and rooftop agriculture. Natural resources are managed with the goal of maximising biodiversity and the health and resilience of ecosystems and many previously-cultivated areas have been restored. Consumers and citizen organisations significantly influence the food production and consumption

landscape and locally-owned and managed businesses emphasise networks and spot markets over large industrial entities. Many European citizens have become prosumers ([4]), producing some of their own food, for example, by growing fruits and vegetables indoors and outdoors. Food value chains are generally shorter and hardly any food products are imported to Europe. Food is locally sourced, seasonal, less processed, plant-based and healthier and is offered by a wide range of outlets beyond supermarkets. These include smaller shops, farmers' markets and community-supported agriculture as well as other citizen-driven projects and movements.

#### *Food consumption in 2050*

Civil society has a strong influence on the organisation of the food system and awareness of sustainable nutrition is high among citizens. Consumers want to connect with their food and learn more about how it is sourced, processed and produced. Nutrition is considered a cornerstone of health and people lead active lives. The dietary shift — motivated by ethical and ecological reasons — away from animal products towards diverse, plant-based and legume-rich diets contributes to reducing diet-associated health problems and GHG emissions. Ready-made meals are still consumed, but the desire for 'exotic' and highly processed food is scarce. Food choices have become healthier. Non-sustainable foods are extremely expensive due to taxes, making sustainable foods the more affordable alternative.

#### *Ensuring access to sufficient, safe, nutritious and healthy food*

In general, food supply chains are short, with processing becoming more localised. This means that there is often a close connection between producer and consumers. To ensure food availability in cities, short, optimised supply chains link them to nearby agricultural areas and food production and urban agriculture is widely practiced. To counteract potential disruptions in the supply chains, a functioning network has been established to redistribute essential foods when there are localised emergencies. The farming profession is highly valued socially due to its vital function and is very well rewarded financially. Some communities have introduced the 'right to food'. Food banks and community support play a larger role in allowing people with low incomes to meet basic nutrition needs. In other communities, universal access to food is ensured through both primary (via factor payments) as well as secondary and tertiary income distribution (via tax systems and income transfers).

### *4.1.5 Food system across the imaginaries*

A cross-imaginary perspective on the potential directions of change for the food system unveils a number of insights — including both opportunities and challenges — that emerge from the forward-looking analysis using the imaginaries.

- Across all imaginaries, a dietary shift from animal-based to plant-based foods is seen as an important strategy to reduce overall GHG emissions and resource use across the food system.

- Alternative proteins sources, including insect-, fungi- and plant-based proteins and cell-based proteins grown from animal cells in the form of cultivated meat and fish are typically a mainstay of such a dietary shift. This is the case despite concerns

([4]) 'Prosumers' are defined here as individuals or groups that both consume and produce renewable energy or offer energy services to the system, such as flexibility or storage (EEA, 2022b).

and uncertainty around their long-term safety profile and potential health risks, the efficacy of regulatory frameworks and the capacity to enforce safety standards.

- Some of the imaginaries are characterised by personalised nutrition and nudging customers towards healthier food and beverage purchases.

- In some imaginaries, agriculture operations are integrated with natural ecosystems — for example, agroecology and agroforestry — to promote the role of ecosystem services in regulating and supporting primary production. In other imaginaries, agriculture operations are integrated with energy operations — for example, agri-voltaics — to promote multiple use land management.

- Food production is often more integrated within human settlements and has an important role in strengthening local economies and increasing social cohesion. It also supports ecosystem services, such as pollination, temperature regulation, water and air purification. In urban areas, food production can take many forms, including vertical farming operations, rooftop gardens, edible gardens and indoor aquaponics.

- Despite their high level of material and energy inputs, digital technologies are perceived to have the potential to streamline operations throughout the food value chain as well as increase energy efficiency and reduce overall GHG emissions and waste.

- Precision farming is an example of a broadly deployed technology across the imaginaries; it implies that a robust digital infrastructure and data flows are in place. Determining who owns and controls such physical infrastructure, software and data flows plays an important role in determining equitability of access, data quality and ensuring responsible use, and thus is likely to be a critical challenge area.

- Labour and skills demand within the food system is a common challenge, though this manifests differently in the imaginaries, that must account for Europe's aging population, skill shortages, job attractiveness, regional inequalities and job displacement as well as community disruptions and resistance.

### 4.2 Mobility system

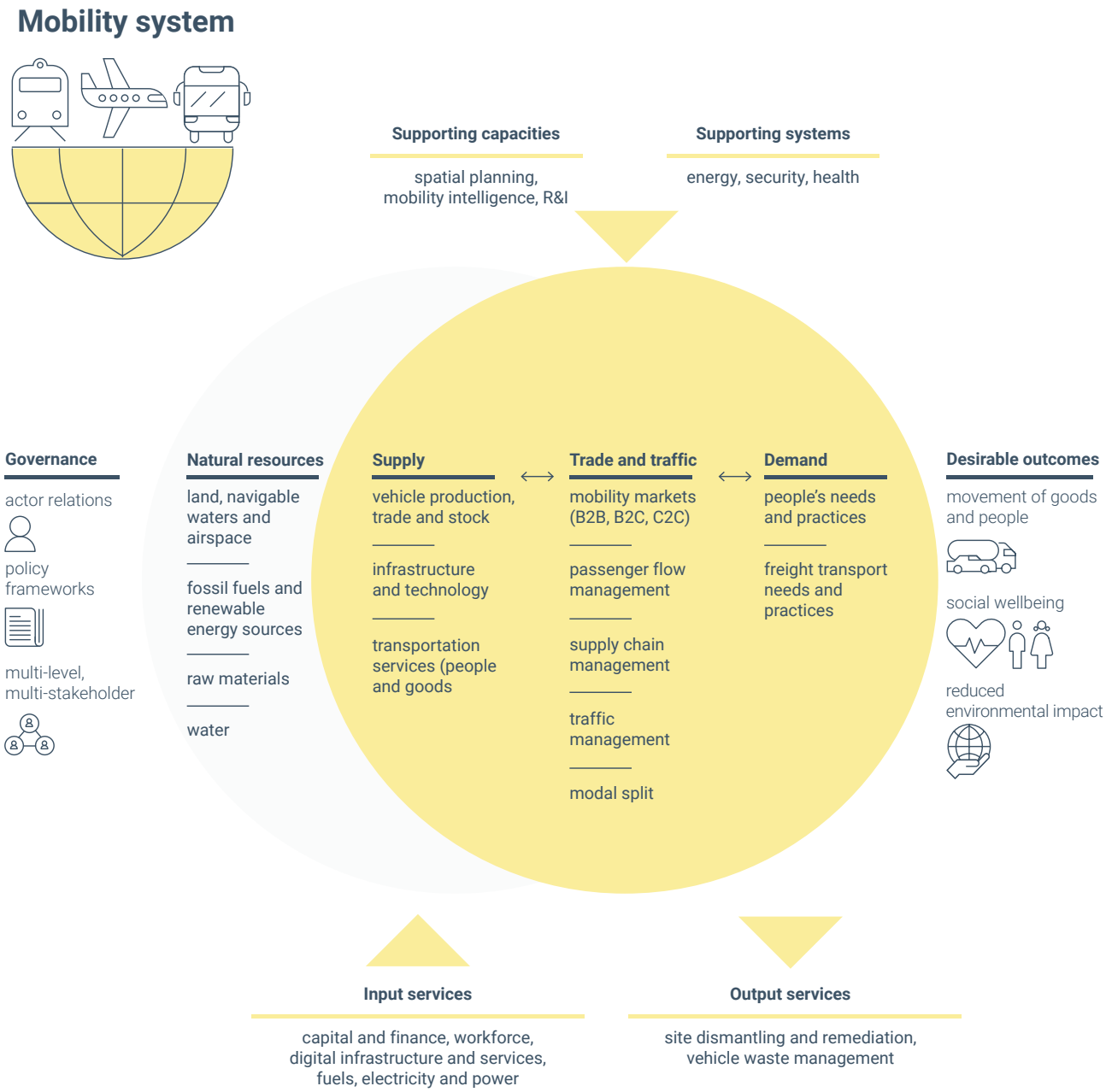
A mobility system spans 'all resources, structures and activities involved in moving physical objects, including both people and goods' (EEA, 2019). It includes personal transportation through motorised and non-motorised private vehicles and on foot, public transportation and distribution of goods through delivery and freight (see Figure 4.2). It also covers the behaviours and preferences of citizens and businesses that drive the demand for mobility. The system relies on infrastructure networks that connect local, regional and national mobility systems with complex global networks of production, consumption, trade and governance. Infrastructure networks encompass roads and cycle paths, fuelling (including hydrogen ($H_2$) refuelling and electric charging infrastructure), parking facilities, railways, airports, inland waterways as well as inland and maritime ports. Mobility systems are multifunctional, multi-actor and deliver a complex and interconnected set of social and economic outcomes — namely ensuring the availability and accessibility of sufficient, safe, comfortable and affordable mobility for all. They are also deeply intertwined with other systems, particularly the built environment, as well as the energy and security systems.

Whilst mobility provides many benefits for its users, it is not without societal costs. GHG emissions, air, noise and water pollution, land use change and biodiversity loss, as well as accidents and congestion, all affect the health and wellbeing of people and the planet. To meet the EU's climate-neutrally goals and zero-pollution ambition, the EU has established a roadmap — the sustainable and smart mobility strategy — to help reduce the GHG emissions of the transport sector and encourage a sustainable, smart and resilient mobility system in Europe (EC, 2020d). Aware of its dependency on imports of critical raw materials from third countries which are crucial to the green and digital transition — including the electrification of the mobility system, defence and aerospace — the EU adopted the European Critical Raw Materials Act (EU, 2024a) to strengthen its critical raw materials capacities and the resilience of its critical raw material supply chain.

Europe's mobility system is constantly evolving. There are a number of trends combining to shape its future. These include: deglobalisation; limitations in the supply of critical raw materials; decarbonisation; automation; digitalisation and cyber security; climate-resilient infrastructure; interactivity with an ageing population and the emergence of novel fuels.


Cover photo: © May Lawrence, Unsplash

**Figure 4.2** **Map of the contemporary mobility system**




**Notes:** This system diagram was used at the mobility workshop as a starting point for exploring how the system might change and appear in the four imaginaries of 2050.

R&I, research and innovation. B2B, business-to-business. B2C, business-to-consumer. C2C, consumer-to-consumer.

**Source:** EEA.

The following sections describe what a sustainable European mobility system could look like in 2050 through the lenses of the four imaginaries, in terms of production, consumption and ensuring access to system products and services.

### 4.2.1 Technocracy for the common good

#### Movement of people in 2050

The strong role of nation states causes notable structural shifts that prioritise national interests over private interests in the spatial pattern of mobility. The backbone of mobility is a digital infrastructure for integrated and multi-modal transport with intermodal mobility chains. Places within and between regions are connected by publicly-controlled collective and autonomous transport systems. These have replaced almost all short-to-medium range air travel and a substantial share of private car travel. Digitalisation and automation reduce the time needed for actions such as shopping, work and related travel, thus freeing-up this time for other activities.

#### Movement of goods in 2050

National government administrations monitor, optimise and control passenger and freight traffic. Autonomous vehicles are ubiquitous — including on roadways, waterways and in aviation — and are underpinned by regulatory frameworks and infrastructure that enable their operations. Individual consumption of goods and services is very high. E-commerce is the predominant form of trade, meaning that travel for private shopping is largely reduced. Circular practices that extend the lifetime of products, such as reusing, refurbishing, repairing and repurposing, are widely established. This means that the transport of primary raw materials (i.e. those extracted from a natural source) is substituted for the transport of secondary raw materials (i.e. those derived from waste). There is a major overhaul of supply chains to enable a switch to regional sourcing. Regional multi-modal distribution centres abound. As long road transport is not decarbonised, there are strong state incentives to transport freight on waterways and on rail. Moreover, travel distances are scaled down due to the reshoring of industry.

#### Ensuring access to reliable and safe mobility

Governments take targeted action to avoid exclusion and ensure vulnerable groups in society — people who are less digitally skilled, on a low income and/or have conditional or reduced mobility — have access to mobility. This includes offering free public transport, subsidised travel-on-demand services in less populated areas, as well as digital literacy programmes.

### 4.2.2 Unity in adversity

#### Movement of people in 2050

EU policies and strategic investments in physical and digital infrastructure have orchestrated a shift towards more local mobility for work and study, an increase in multiple types of sharing arrangements and also mobility-as-a-service (MaaS) solutions. These actions are complemented by the promotion of active mobility modes, such as walking and cycling, through an adequate and safe infrastructure network and incentivisation schema. Many activities have now been fully hybridised with digital options, for instance shopping behaviour is characterised by online shopping and collective delivery arrangements. Tourism is mainly regional, focusing on carbon-neutral and low-emission activities. Across the mobility spectrum, unsustainable behaviours, such as private automobile use and general aviation, are actively discouraged through various financial incentives and policies.

#### *Movement of goods in 2050*

The movement of goods, including their GHG emissions, is highly regulated and monitored by strong European institutions focused on reducing emissions through the promotion of circularity and collaboration on transport chains. The changes in infrastructure and transport networks prioritise multi-modal transport and densification of economic activities around transport hubs. In particular, road transport is subject to stringent regulations and restrictions. It is also highly taxed. Urban freight transport relies on zero-emission vehicles, dynamic routing and improved multimodal connections. Overall, there is an emphasis on resilient short-distance and supply chains and transport networks that are highly digitalised to optimise performance and energy efficiency.

#### *Ensuring access to reliable and safe mobility*

Walkable cities and affordable public transport services (i.e. buses, trains and MaaS) meet most mobility needs. In addition, subsidies and regulations for shared transport bolster and institutionalise solidarity for people with restricted mobility. This is ensured by investments in multi-modal public transport capacities, accounting for fluctuations in demand while stabilising costs at affordable rates. This includes a centrally governed and secure digital platform to facilitate efficient booking systems for ubiquitous mobility service access. Safety standards are enforced by federal authorities, with EU legislation setting unified standards and conditions for safe mobility. Control authorities, coordinated at the EU-level, manage the system's infrastructures and capacities to limit the effects of service disruptions such as cyberattacks and extreme weather events. The control authorities also promptly deploy additional mobility resources to locations in need. In the event of stranded passengers, accommodation can be made available, free of charge.

### *4.2.3 The great decoupling*

#### *Movement of people in 2050*

Overall, people are moving more in their leisure time, while teleworking and digital education options require fewer journeys. Many people prefer to spend their afternoons and evenings in their suburbs and their weekends in rural recreation areas, exploring nature and using active forms of mobility such as e-bikes or hiking. In urban areas, on-demand mobility services — often using autonomous electric vehicles — integrated with MaaS solutions are a popular choice. This is because they enable individuals to access a range of public and private transportation modes in real-time. Mobility in peripheral and sparsely-populated rural areas focuses on serving individual transport needs with demand-oriented solutions. With an aging population in Europe, the design of urban areas as '15-minute cities' ([5]) guides local transport system design decisions. Carbon-neutral business models in the transport sector internalise negative environmental externalities in pricing. Technological innovations accelerate the spread of new mobility patterns and routines, including in tourism.

#### *Movement of goods in 2050*

A variety of transport modes are used, including pipelines for material flows, sea and river shipping, trains and aeroplanes. Digital logistics systems connect intermodal hubs throughout Europe with drones and robots delivering the last mile to the

([5]) Cities in which people are able to meet most of their daily needs within a 15-minute walk, cycle or local public transport trip from their homes.

consumer, for example for food and meals. Compared to consumer goods, the transport routes for food are significantly shorter. On-site, mobile processing stations are available, directly accompanied by local (bicycle) courier services so that organic products can be delivered directly to consumers. In city centres, localised production facilities — using 3-dimensional (3D) printing, for example — reduce the need for long-distance transportation.

***Ensuring access to reliable and safe mobility***

Social innovations such as crowd-sourced mobility sharing platforms and on-demand services provide affordable mobility where public transport networks fall short. Service providers use tracking, AI technologies and user data to provide timely and affordable transport. For cybersecurity reasons, the system is diversified and equipped with a high number of multimodal hubs and alternative modes of transport. To make the rather complex, differentiated system easy to use, the companies sponsor barrier-free on-demand online instructions and helpdesks. This bolsters digital literacy among the users. The profit margins of private mobility providers are high and are taxed for additional state-funded provision of mobility services in rural, remote areas.

### *4.2.4 Ecotopia*

***Movement of people in 2050***

Life happens locally. Urban areas are designed as '15-minute cities', where independent businesses, local services and small shops flourish. The movement of people takes place across short distances using active and micro-mobility modes (enabled by local and regional cycling networks), community-organised peer-to-peer shared mobility services and zero-emissions public transport. A fundamental shift in consumption habits towards sufficiency and more frugal lifestyles resulted in a decline in resource use and consumption for a variety of goods. There is a tendency for people to repair their products rather than purchase new ones. Reduced working hours means there is more time available for cultural and leisure activities, including physical exercise. These activities tend to happen locally. Similarly, most trips for study and work purposes (a significant proportion of which takes place virtually) happen locally. Longer journey times for long-distance travel are accepted. Consequently, national and European level travel (e.g. for tourism or to visit friends and family) typically takes place using zero-emission, intra-EU rail transport.

***Movement of goods in 2050***

Food and other goods are primarily produced locally or regionally, resulting in shorter delivery routes and supply chains. A decline in consumerism accompanied by circularity principles — such as reuse, repair and refurbish (enabled by modular design) — results in less waste and fewer raw materials and products being shipped. This therefore reduces transport needs. At the same time, secondary raw materials play an increased role in manufacturing processes. Social enterprises and cooperatives, using energy-efficient, zero-emissions transport modes, play an important role in freight transport. Logistic operations and freight services are supported by regional storage and distribution hubs.

***Ensuring access to reliable and safe mobility***

The transport system is barrier-free and affordable for all, supported by shared values and social norms that foster solidarity. Community transport providers ensure a minimum level of service and equal access, including for people with restricted

mobility. Rural areas offer mobility services for non-car users and flexible pricing systems for people on a low income. Digital inclusion is promoted to ensure all citizens can use digital services and is often realised as peer-to-peer support among neighbours. Traffic safety is promoted by community actors, through initiatives such as educational programmes, campaigns and speed control mechanisms.

### *4.2.5 Mobility system across the imaginaries*

A cross-imaginary perspective on the potential directions of change for the mobility system unveils a number of insights — including both opportunities and challenges — that emerge from the forward-looking analysis using the imaginaries.

- Digitalisation, including AI, is perceived as a necessary condition for improving the safety, accessibility, interoperability, efficiency and sustainability of mobility systems, as illustrated below. However, digital systems have their own energy and material requirements. They are also dependent on data being shared from multiple mobility sources and require various layers of security and privacy protection. Opportunities that stem from digitalisation include:
  - the organisation of system services and development of intermodal services for passengers and freight that meet individual needs and overall demand patterns, whilst reducing energy demands and relieving traffic congestion;
  - broad accessibility to mobility services;
  - monitoring of emissions reductions, energy efficiency and additional data-driven actions resulting from policies and standards;
  - the lifecycles of various materials being extended; and
  - logistics and goods transport being coordinated in an energy efficient manner.
- Electrification is viewed as a critical factor in reducing fossil-fuel dependence and associated emissions. However, lifecycle emissions of electric vehicles are non-negligible and the demand for critical raw materials driven by vehicle electrification poses serious threats for the environment (including the deep sea) along their supply chain.
- Beyond electrification, the decarbonisation of mobility is assumed to include a reduction in vehicles (especially automobiles) and/or a reduction in the overall mobility demand due to telework, spatial planning, urban densification, shorter and optimised supply chains and shifts in values and behaviours. There are health benefits resulting from reduced pollution (e.g. noise, air and micro-plastics from tyres) and active mobility.
- Extensive investments in public transport infrastructure, both physical and digital, play a central role in most imaginaries. This is particularly the case for rail systems and fleets for MaaS operations.
- The central importance of mobility systems for societies mean that system shifts imply broad and diverse cross-systemic impacts. Consequently, modes of social organisation (e.g. car-centric cities) and lifestyles are fundamentally disrupted as a result of the transformation of concepts and requirements around mobility.

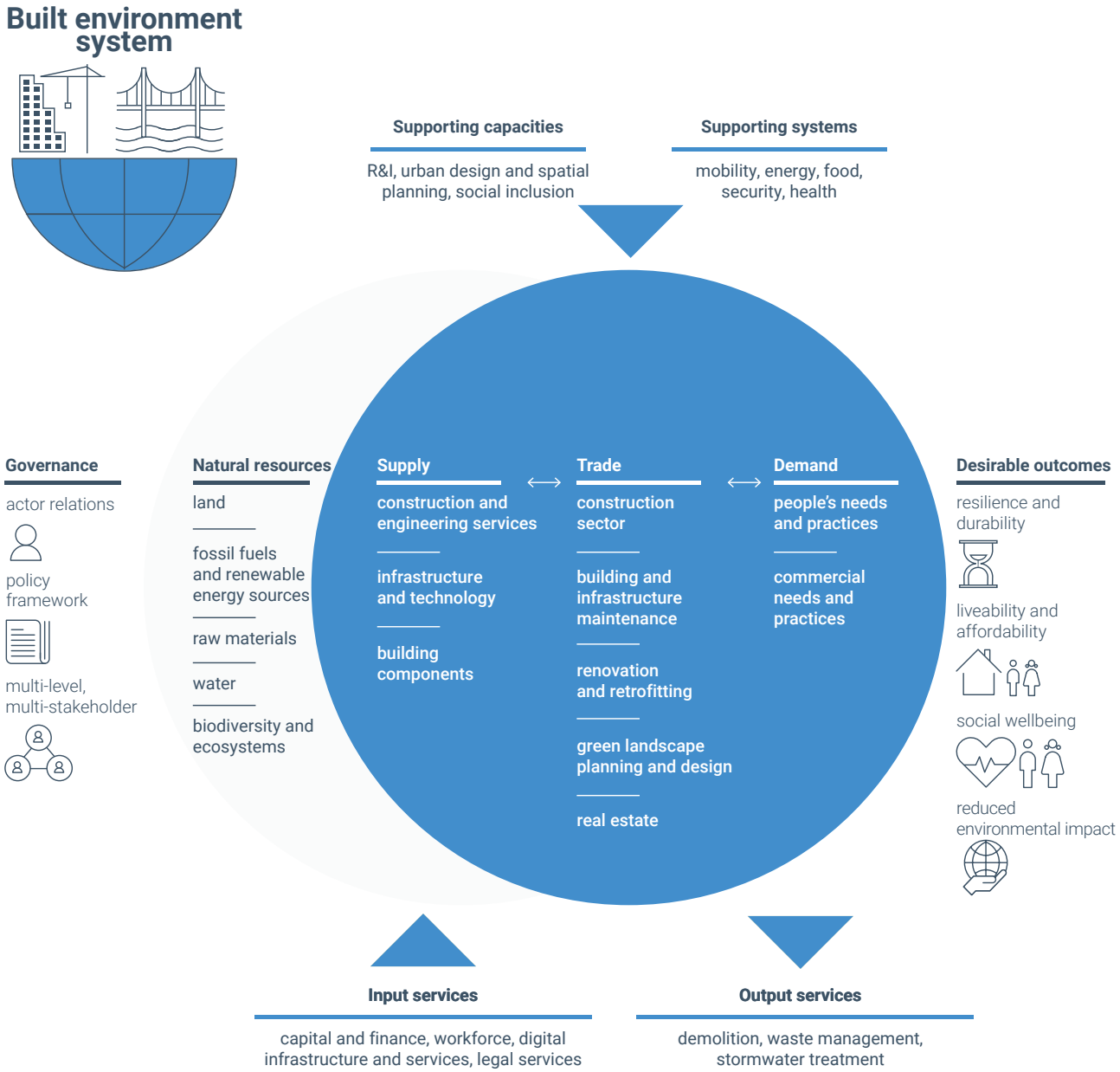
### 4.3 Built environment system

The built environment system consists of everything people live in and around, such as housing, commercial buildings, transport, infrastructure and public spaces. It also encompasses urban design and land-use planning, as well as the interplay between physical structures, social dynamics and nature (see Figure 4.3). The built environment is deeply intertwined with the mobility and energy systems. It influences the well-being of people and communities, affecting their physical and mental health, mobility, social interactions and participation in public life (OECD, 2023).

Since current estimates suggest that more than 85% of the buildings that exist today are likely to still be in use in 2050 (EC, 2020b), the map of the built environment system must be considered in conjunction with the building life cycle. This cycle goes from raw material extraction, design and production, construction, use and renovation (by far the longest stage), to end-of-life stages (see Figure 4.4) (EEA, 2024d). Each stage of the building life cycle results in pressures on the environment and climate. Buildings are responsible for 42% of the EU's annual energy consumption, 35% of annual GHG emissions and around one third of all materials consumed annually in the EU. Conversely, buildings also represent a EUR 1.7 trillion industry, providing more than 20 million jobs (EEA, 2024d). EU policies target different aspects of buildings, from energy efficiency, GHG emissions, renovation and circularity. Yet, there is no holistic policy approach to buildings that approaches them as a system across their whole life cycle and integrates both environmental and climate issues (EEA, 2024d).

Cover photo: © Nicola Zhukov, Unsplash

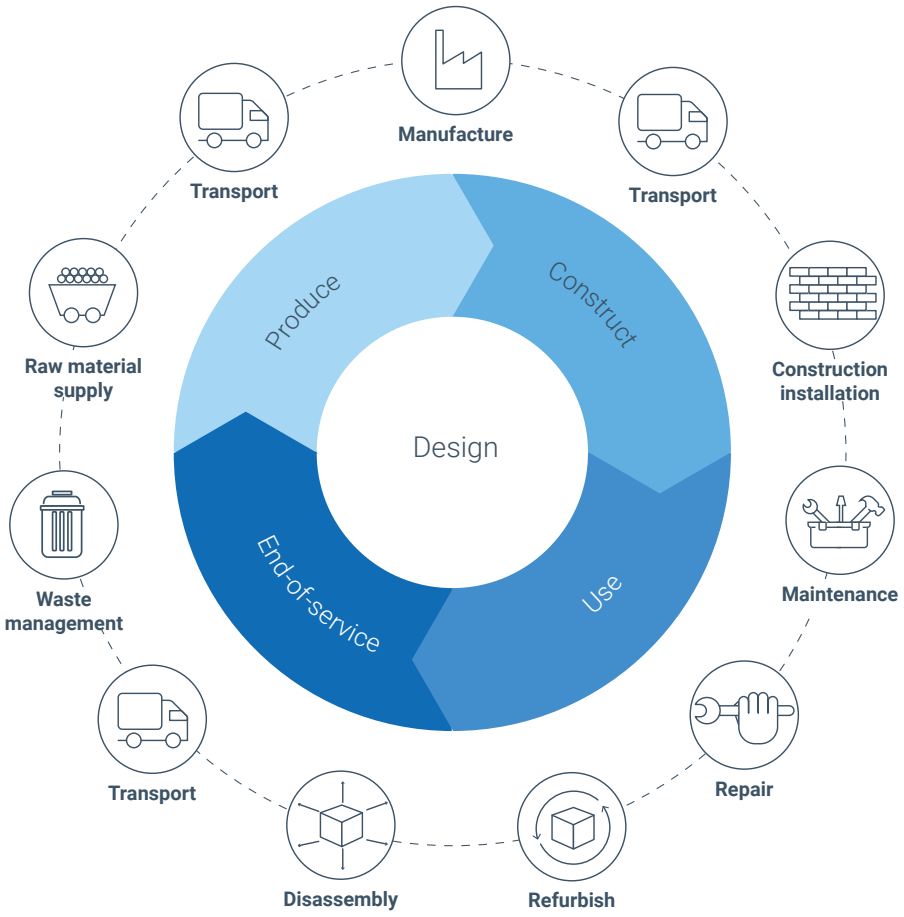
**Figure 4.3** **Map of contemporary built environment system**




**Notes:** This system diagram was used at the built environment workshop as a starting point for exploring how the system might change and appear in the four imaginaries of 2050.

**Source:** EEA.

**Figure 4.4 The building life cycle**




**Notes:** The different phases and sub-phases of the building life cycle can inform the design of buildings and other components of the built environment.

**Source:** Adapted from TU Delft, 2024.

The future of Europe's built environment is shaped by a variety of trends. These range from an aging population, continuing urbanisation, decarbonisation, digitalisation and automation, material reuse and emergence of new materials, nature-based solutions and offsite construction, to circular renovation strategies.

The following sections describe what a sustainable European built environment system could look like in 2050 through the lenses of the four imaginaries, in terms of production, consumption and ensuring access to system products and services.

### 4.3.1 Technocracy for the common good

#### Settlements in 2050

Nation states play a key role in the governance of the built environment, namely in spatial and urban planning and in setting building regulations and standards. Central authorities affect policy on settlement concentration, high-capacity transport infrastructure and in stocks and flows of the construction sector. Urban areas are regulated to encourage population density, accompanied by easy access to services. Populations are diversified according to demographics and relative household wealth to avoid segregation or other social divisions. Rather than demolition and new building projects, renovation, retrofitting and maintenance of the large stock of existing buildings is prioritised by national governments. Respective policies incentivise durable and circular materials, modular building components, digital integration and the increase of a building's lifespan. Nature-based infrastructure solutions, including for water management, are required instruments for climate change mitigation and adaptation in urban areas. This results in reduced climate risks such as flooding and heat, enhanced biodiversity, the generation of renewable energy and food production as well as recreation.

#### Buildings in 2050

Multiple occupancy buildings are reducing building footprints in urban areas. Buildings are digitally connected, monitored and optimised by digital building management systems (BMSs) for energy efficiency, temperature regulation, collection and recycling of greywater and occupant behaviour. Gardens, green roofs and living facades improve the thermal comfort of buildings, enhance biodiversity and are used for food production. Many buildings include multi-purpose shared spaces for recreation, co-working and community interaction. National regulations encourage the development of standardised construction parts (for simplified deconstruction, reuse and recyclability), while allowing for visual customisation.

#### Ensuring access to liveable and affordable housing

A range of regulations for taxes, investments in public spaces, subsidies and social housing ensure fair access to liveable and affordable housing. Public subsidies and personalised support for improving living conditions and ensuring a decent quality-of-life are available to vulnerable groups. Most residential areas are self-sufficient units that provide proximity to all necessary services, green and/or blue spaces — such as parks, urban forests, tree-lined streets, allotments, ponds, lakes, riverbanks and coastlines — and intermodal mobility hubs. These revitalised urban neighbourhoods create new work opportunities, facilitate sustainable e-commerce and encourage inclusive living.

### 4.3.2 Unity in adversity

#### Settlements in 2050

Human settlements are a vibrant tapestry of green spaces, community centres and mixed-use buildings with accessibility being a prominent design parameter. The EU and state governments have led heavy investment into retrofitting existing housing to extend their lifecycle, while transforming urban landscapes so that living, working, healthcare, education and shopping are all within a short walk or bike ride. Mixed-function urban spaces host diverse activities and foster vibrant cultures and community. The built environment is digitally networked to enable a wide variety of digital services. Green roofs, biodiversity corridors and nature-based solutions harmonise human settlements with their natural environments and

ecosystem services. Well-connected peri-urban areas have been transformed to host biodiversity-rich areas, providing many ecosystem services.

#### *Buildings in 2050*

Buildings are designed for long-term economic and social viability. The architecture is of high quality, associated with higher value, lower maintenance costs and climate resilience. Buildings and their environments are in symbiosis — trees provide a cooling effect and rainwater harvesting systems are designed to capture and stock rainwater. Roofs are green or white to improve thermal conditions or alternatively are covered in solar panels. Warehouses are covered in greenery and buildings feature less uncovered glass. Advanced monitoring systems and digital infrastructure ensure resource efficiency via automated temperature regulation and managed energy flows, helping to create energy-positive districts where possible.

#### *Ensuring access to liveable and affordable housing*

Affordable housing programmes strike a balance between public and private production, supported by individual renovation roadmaps and schemes focused on retrofitting properties. Social housing providers accelerate turnover in dwellings. This ensures fuller capacity occupation and orchestrates movement of households into spaces that are the best fit for their needs. Additionally, state-financed affordable housing ensures access to quality, affordable homes for all. The real estate market has been reset to improve affordability for renters and to open pathways for tenants to become buyers. This is supported, in part, by the planned retrofitting of existing structures that creates more dwellings out of the same floor space. It also includes affordable residential units for both renters and private ownership.

### *4.3.3 The great decoupling*

#### *Settlements in 2050*

Settlements are characterised by a balance of new buildings and renovations integrated with open green areas and extensive tree cover. Multi-storey buildings with integrated photovoltaic systems and landing sites for delivery drones are the dominant building type. Plants on the facades and roofs characterise the cityscape and provide cooling effects. The trend is towards biophilic design, with apartment blocks composed of modular, flexible and adaptable living spaces. This raises water retention capacities and climate resilience. Corporate and government buildings offer open plan offices and many companies promote coworking spaces for remote workers. Craft businesses, small workshops and recycling centres develop circular economy innovations at shared workspaces close to the city. Green spaces are connected to residential areas for recreation and local food supply.

#### *Buildings in 2050*

The building architecture is optimised with technological innovations in terms of energy efficiency and climate protection. New buildings are often made of wood and innovative materials with a high recycled content and re-used components. The use of bio composites and other bio-based materials is incentivised through market policy and environmental regulations. At the same time, reinforced concrete remains an important building material due to innovations in concrete mixtures and carbon-neutral cement production. Many buildings in urban areas are active energy hubs in the municipal energy grid. The use of digital BMSs combines intelligent monitoring of aspects such as water, lighting, heating, cooling and ventilation to maximise energy efficiency and comfort. Roofs and façades are used for water systems, energy generation, natural cooling and food supply.

#### *Ensuring access to liveable and affordable housing*

Access to liveable and affordable housing can be a challenge due to high housing prices. Governments typically act as guardians by offering long-term low-interest financing opportunities and housing support for vulnerable groups. The modular and flexible designs make it easier to adapt flat sizes to household needs and help to keep prices within affordable ranges. Low-income households receive financial support for energy renovations. In regions with a high proportion of old building stock, governments subsidise do-it-yourself (DIY) kits for low-cost solar energy, insulation or water treatment systems. The principle of planning equity is starting to take hold in many urban areas, involving citizens and all stakeholders in housing and urban planning with an emphasis on the needs and opinions of vulnerable groups.

### *4.3.4 Ecotopia*

#### *Settlements in 2050*

Human settlements of all sizes have focused on creating self-sufficient and expressive communities of mutual care and support. They have prioritised the (re) integration of nature within and between communities. This includes natural and restored ecosystems, nature-based solutions and blue-green infrastructure to promote ecosystem services (food, clean air, fresh water, climate regulation and carbon sequestration), climate resilience and a deeper connection to nature. Shared spaces enable neighbours to provide one another with services, to labour fruitfully together and to live in ways that reinforce the values of cooperation, sufficiency, respect and care for all living beings. Denser urban areas are often punctuated with 'tree bouquets', spires of green vertical farms, rooftop gardens and large shade sails that provide cover and reduce heat generation in public spaces (and in some cases produce electricity).

#### *Buildings in 2050*

The maintenance of buildings and infrastructure that preserves the aesthetics of heritage buildings is a top priority for communities. It focuses on the concept of minimum intervention and passive solutions to maintain the architectural design style that reflects the local geographic and cultural context. In non-heritage buildings, envelope efficiency focused renovations and retrofitting — addressing insulation of roofs, outer walls and other components for temperature regulation — are realised through community work programmes and often result in unique localised aesthetics. During renovations, a variety of locally sourced materials are utilised to improve insulation and energy efficiency. These materials include unfired clay bricks with various additives, wood, fibres and recycled glass. Residential buildings have been redesigned for higher occupancy rates and to include co-living spaces that foster reduced consumption, inter-generational living, community caregiving and inclusivity. Unused commercial and industrial buildings in urban and peri-urban environments have either been redesigned as residential or mixed-use buildings, or carefully deconstructed to provide secondary raw materials for renovation and to create green and blue spaces.

#### *Ensuring access to liveable and affordable housing*

The redesign of residential buildings for higher occupancy rates and the creation of shared common spaces, alongside the renovation and conversion of commercial and industrial buildings play a key role in meeting the housing demand and reducing living costs. Governments typically offer initial funding for these types of projects, coupled with long-term low-interest loans, to the entities who initiate them. In addition, progressive taxation, rent freezes for low-income tenants and a variety of other support programmes are offered by local governments.

### *4.3.5 Built environment system across the imaginaries*

A cross-imaginary perspective on the potential directions of change for the built environment system unveils a number of insights — including both opportunities and challenges — that emerge from the forward-looking analysis using the imaginaries.

- In all imaginaries, the redesign, repurposing and renovation of the existing building stock feature as strategies aiming to extend the lifespan and utility of the existing building stock. With a focus on energy efficiency, material reuse and recycling, these strategies seek to reduce GHG emissions and resource use across the building life cycle.

- Some imaginaries show a tendency towards modular construction and the integration of novel materials, including bio composites made from renewable resources and other bio-based materials.

- The repurposing and renovation of buildings require construction materials (traditional and novel, virgin or recycled), as well as critical raw materials (primary or secondary) for the integration of digital infrastructure. These material requirements pose important environmental, climate, social, ethical and economic questions. Trade-offs therefore need to be carefully examined and balanced.

- Material reuse and recycling foment innovation in resource circularity and recycling processes. However, a barrier to reuse is often the loss of technical properties of building materials such as recycled concrete.

- Human settlements typically integrate natural ecosystems across the imaginaries, albeit in different ways. This integration enhances biodiversity, delivers ecosystem-services and supports climate change mitigation and adaption strategies. It also has a positive effect on human health and wellbeing. Nevertheless, questions around inequalities ([6]) in relation to access to green spaces require attention, particularly in urban transformation processes.

- In most imaginaries, the built environment is highly digitalised with intelligent monitors and embedded smart sensors. These collect real-time data to optimise energy and resource use, enhance occupant comfort and ensure building maintenance. Aside from the obvious requirements for material inputs, energy and skilled labour, these digital systems require robust privacy and security measures to safeguard the data they collect from unauthorised access and thus protect the rights and privacy of individuals.

- In some of the imaginaries, mixed-use buildings featuring shared common areas or co-living spaces encourage inter-generational and intercultural exchanges across ages, cultures and backgrounds. This illustrates how the transformation of the built environment, when supported by adequate regulations and funding mechanisms, can help promote demographic diversity, integration and ownership. This is especially the case if citizens are actively engaged in the co-design of public spaces.

- Similarly, the analysis illustrates the importance of the redesign of the built environment in promoting accessibility to essential services. This helps reduce individual transport needs, encourage active transport modes and promote overall road safety.

([6]) More information on socio-inequalities in the access to urban green and blue spaces across Europe can be found in EEA (2022c).

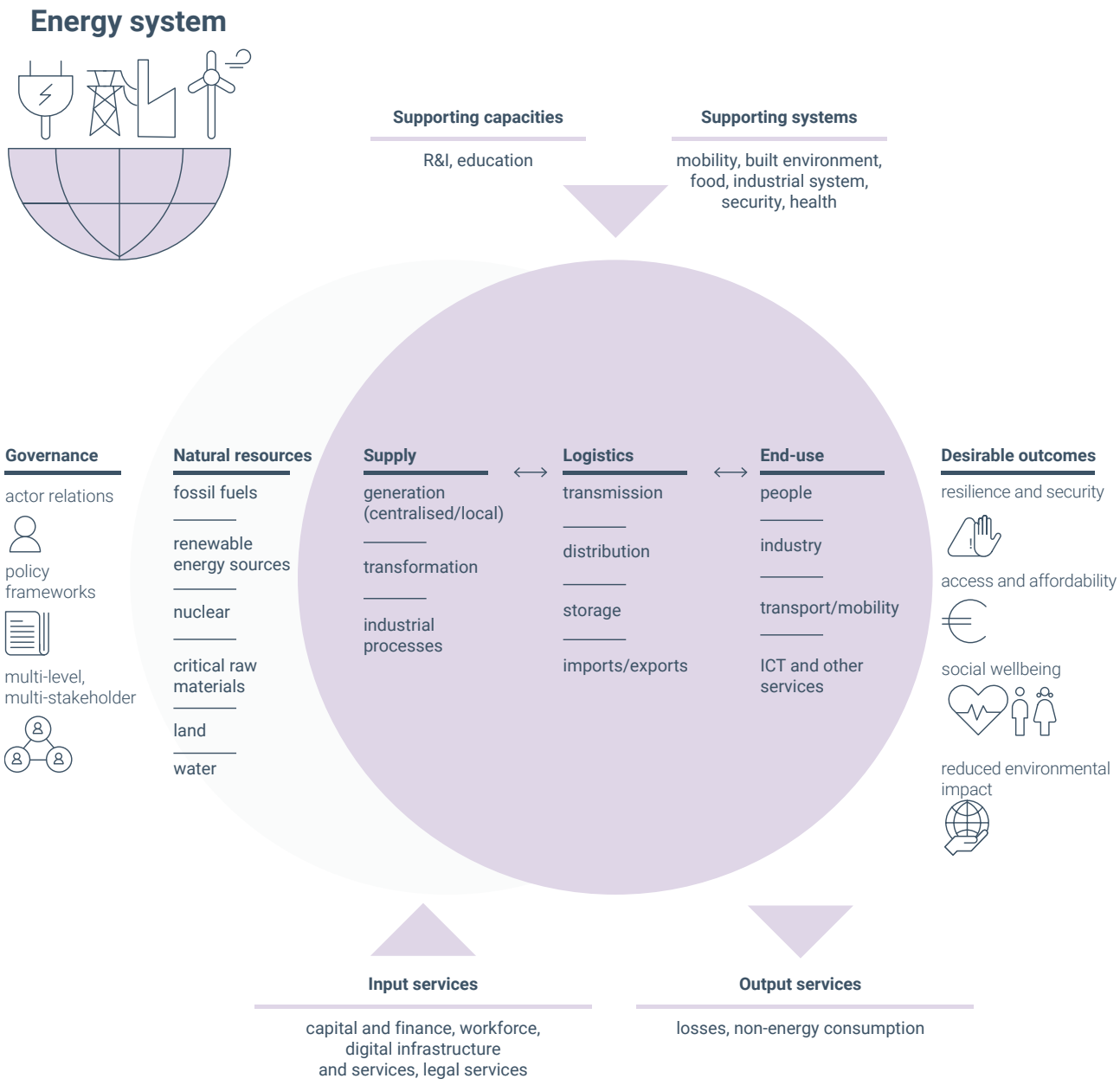
### 4.4 Energy system

The energy system spans across all resources, infrastructures, activities and actors directly and indirectly involved in energy production, conversion, delivery, storage, end-use and governance (Figure 4.5). The energy system in Europe is extremely diverse, particularly in terms of the energy mix, market liberalisation, the age of the energy infrastructure, carbon intensity and consumption levels (EEA, 2019).

While it underpins all other core systems of production and consumption, providing them with the energy carriers they need, the energy system also creates a wide range of pressures. These fall on the environment, climate and human health, including GHG emissions; air pollution; water and soil contamination; land use and the generation of waste. Policy initiatives put forward under the European Green Deal aim to make the EU climate-neutral by 2050 (EU, 2021). They also aim to accelerate the deployment of renewable energy sources (RESs) (EU, 2024b) and to increase the interconnectedness of the energy system to improve its ability to produce and distribute energy more efficiently and effectively (EC, 2020c). In addition to these initiatives, the Critical Raw Materials Act (EU, 2024a) aims to increase the manufacture of 'net-zero' technologies within the EU and ensure a secure, sustainable and competitive supply chain for clean energy.

Cover photo: © Federico Beccari, Unsplash

**Figure 4.5** **Map of contemporary energy system**




**Notes:** This system diagram was used at the energy workshop as a starting point for exploring how the system might change and appear in the four imaginaries of 2050.

R&I, research and innovation.

**Source:** EEA.

Europe's energy system is shaped by emerging trends. These consist of: digitalisation; cybersecurity threats; electrification; competition for critical raw materials; the emergence of efficient and connected houses; neighbourhoods and cities; the transition from consumers to 'prosumagers' (combining production, consumption and storage of energy) and the move towards a circular, low-carbon industry.

The following sections describe what a sustainable European energy system could look like in 2050 through the lenses of the four imaginaries, in terms of production, consumption and ensuring access to system products and service.

### 4.4.1 Technocracy for the common good

#### Energy supply in 2050

Individual nations see energy production as a public good and have prioritised large-scale clean, renewable energy production facilities under public ownership. These include: on- and off-shore wind; solar arrays; concentrated solar power; tidal and temperature differential coastal energy and geothermal energy. Large-scale energy production is complemented by localised energy production, particularly in urban areas and in isolated regions and communities. These local projects are often associated with the redesign and renovation of buildings and play an important role in managing peak loads. Even though the emphasis is on centrally-managed distributed renewable energy production, some countries have prolonged their nuclear power path. Furthermore, the strategic construction and operation of a trans-European hydrogen distribution system has created a resilient and reliable power source for many. It has also changed some of the state-to-state dynamics of energy flows.

#### Energy demand in 2050

National investments in the modernisation, enhancement and integration of energy grids have enabled large energy efficiency gains, particularly the addition of new high-voltage transmission lines. The installation of advanced monitoring systems has advanced peak load management of the grid and guarantees reliable energy flows. To complement the integration of large renewable projects in supply systems, energy storage facilities have been funded and installed by states, through state-controlled companies and cooperatives.

#### Ensuring access to affordable and reliable clean energy

The public ownership of renewable energy production, grids and storage results in system cost savings that are reinvested to ensure broad access to affordable and reliable clean energy. In addition, small-scale, government-subsidised energy production projects at the peripheries of national grids ensure the affordability and reliability of clean energy. Subsidiary energy companies bridge communication between communities and the centralised energy providers and serve an important role in balancing the decision-making processes of centralised demand-side aggregators.

### 4.4.2 Unity in adversity

#### Energy supply in 2050

Europe's energy landscape is marked by a shift towards Renewable Energy Sources (RESs). It is focused on wind, solar and biomass fuels coupled with infrastructures like smart grids, meters and advanced battery solutions, optimised to address supply variability. The EU has funded large-scale renewable energy projects, according to local conditions, as well as smaller scale renewable energy projects. These projects aim to improve system resiliency and stability and help communities and urban areas to be more self-sufficient and resilient against shocks and disruptions. Energy distribution systems accommodate growth in RESs, including battery reserve systems with grid integration, real-time monitoring and largely automated

flow management controls. Distribution system operators (DSOs) ensure system stability and reliability and are partially governed by local councils to help safeguard community access.

#### *Energy demand in 2050*

Europe's energy demand has been moulded by stringent EU regulatory frameworks combined with governance models that foster collaboration between different government levels and actors, technological evolution and heightened environmental consciousness. The energy end-use sectors (industry, services, residential and transport) experience a shift towards demand-response solutions. The highly electrified industrial sector has incorporated renewable hydrogen, while the transport sector has invested in modal shifts, infrastructure improvements focusing on rail transport and new fuels in maritime and aviation sectors. Facilitated by policy frameworks and digital tools, awareness of carbon footprints among consumers has resulted in lowered energy consumption in households and become a driving force for electrification, energy efficiency and individualised energy services through smart solutions.

#### *Ensuring access to affordable and reliable clean energy*

Europe's energy policies place strong emphasis on access equity, supported by comprehensive subsidy schemes and cash transfers across Europe. To make clean energy affordable and reliable, the resilience and efficiency of local distribution infrastructures has become key. Local renewable energy projects support the large-scale energy production operations governed by the EU and guarantee energy access in times of crisis or disrupted service. Market reforms encourage changes of consumption patterns and support citizen-centric business models that enable residential, commercial or industrial customers to trade energy amongst themselves or with the grid. This is known as peer-to-peer energy trading.

### *4.4.3 The great decoupling*

#### *Energy supply in 2050*

The energy mix in Europe varies, although RESs such as hydropower, wind and solar energy (depending on the region), biomass and hydrogen (the main energy source in large and heavy industries) play a central role. New infrastructures have emerged for this, such as energy storage and hydrogen distribution networks. New markets have also developed, with regional suppliers cooperating with global partners for raw material supply. Due to a liberalised energy market and regional differences in the availability of resources, energy production is organised in a highly decentralised manner with multiple local and regional energy production nodes and storage facilities. Prosumers are important market players at the local level. Supported by government incentives, companies innovate in power generation, management of resources such as biomass and bio-based waste, network operations and demand management. Many companies create new products in the field of 'power-to-X' to enable the conversion (and storage) of surplus electricity from renewable sources into carbon-neutral synthetic fuels, such as hydrogen, synthetic natural gas, liquid fuels, or chemicals.

#### *Energy demand in 2050*

Energy demand remains high due to mobility and transport needs, a flourishing bioeconomy industry, digitalisation, AI and cloud computing. Frugal energy consumption is not a concern for consumers or industry. Industry is responding

to electricity prices with more automation and machine learning to make energy efficiency gains. Ultimately, citizen consumption patterns have diversified to accommodate different lifestyles shaped by flexible mobile work and a digital economy.

***Ensuring access to affordable and reliable clean energy***

Access to affordable and clean energy for all is a constant challenge in view of the strong competition on the energy markets. In Member States, there is typically a mix of some self-sufficient, off-grid consumers and many others who are dependent on the central grid. Protection and empowerment measures are needed for vulnerable groups. These include informing consumers about their choices and safeguarding so that no-one is decoupled from the grids. Some countries have introduced a redistribution system, for example, using climate taxes, to promote a fairer distribution of costs.

### *4.4.4 Ecotopia*

***Energy supply 2050***

Energy is sourced solely from renewable and sustainable sources, employing a highly decentralised and localised approach to energy generation. This empowers local communities to organise and manage their energy needs efficiently. Many energy communities are prosumers and self-sufficient. Local energy grids and energy communities are tailored to the local energy needs and available energy sources. Fossil fuels are no longer imported to Europe, resulting in the decommissioning and repurposing of fossil fuel energy infrastructures, as well as the recovery of valuable material resources. Based on local resources, different technologies are used for energy storage facilities. The distribution infrastructure is responsive to demand through interconnected, local, smart grids. Sustainable financing and pricing are achieved through micro-credits provided by communities and governments, enabling the development of a sustainable energy system.

***Energy demand 2050***

The rejection of consumerism and the uphold of sufficiency and frugality as shared values has led to a conscious reduction in the overall energy demand across the various end-use sectors such as industry, housing and transport. This has led to a proportionate reduction in energy production. Energy requirements to produce materials and goods is low due to limited demand and a sharing economy. Energy demand for temperature regulation of buildings is also low as communities encourage co-living and co-working spaces and buildings are well insulated. In addition, the local production of goods shortens transport distances and lowers the energy needs of the mobility system. The proximity of services and the focus on active and community-organised peer-to-peer shared mobility services as well as zero-emissions public transport has reduced the number of vehicles and improved overall transport efficiency.

***Ensuring access to affordable and reliable clean energy***

Due to low demand, producing sufficient energy to ensure affordable access is not a problem. To enable individuals and local organisations to afford the infrastructure to become prosumers, micro-credits, subsidies and communal support, such as shared use and appliance repairs, are facilitated by governments and energy communities. The abundance of local and diverse small-scale renewable energy systems,

combined with interconnected community energy grids make the energy system resilient against disruptions in energy supply.

### *4.4.5 Energy system across the imaginaries*

A cross-imaginary perspective on the potential directions of change for the energy system unveils a number of insights — including both opportunities and challenges — that emerge from the forward-looking analysis using the imaginaries.

- In all imaginaries, the development and increased deployment of renewable energy production systems play a critical role in reducing the use of fossil fuels and reaching European decarbonisation targets. Such fossil fuel reduction draws attention to the need for the responsible phaseout, re-purposing and/or retrofitting of existing fossil fuel generation facilities and infrastructures. This is the case both nationally and regionally at the transmission-level, as well as locally at the distribution-level.

- 'Prosumption' emerges as an important strategy for fostering energy system resilience, improving energy access and affordability and also promoting community self-sufficiency.

- Energy storage capacity is a necessary investment in all imaginaries, complementing prosumer energy distribution grids. This includes smaller units for households or communities and also larger storage facilities created with grid improvements.

- Upgrading and integrating the energy distribution grids across Europe for improved efficiencies is a core strategy in several imaginaries. Digitalisation across the energy system is a key component of energy flow management in all imaginaries. Advanced systems for semi- or fully automated energy demand management with complimentary intelligent monitoring systems play an important role in all reimagined energy grid systems.

- The strategic deployment of clean hydrogen takes place in several imaginaries to match key demands with supply centres, often to transition transport and heavy industry away from fossil fuels. Strategic deployment is key to ensuring that hydrogen infrastructure is not misplaced.

- Biofuels play an important role in the energy mixes of several imaginaries. They contribute to the decarbonisation of the energy system, although their demand likely exceeds supply. At the same time, burning biofuel is a source of local pollution due to the release of particulate matter and other pollutants during combustion. This pollution has impacts on air quality and human health and requires attention.

- In all imaginaries, measures to improve the energy performance of buildings play a key role in reducing GHG emissions and achieving carbon-neutrality goals.

- Despite the adoption of circularity principles, there are significant challenges to the decarbonisation of the energy system in the different imaginaries. These are posed by the material requirements of renewable energy production, distribution and storage technologies and infrastructure, the resilience of supply chains as well as the implied environmental impacts of extraction and refinement in Europe and beyond. The demand for workers with the right skillset is also a challenge, which can result in critical bottlenecks that hinder the energy transition.

## 4.5 Cross-system interactions

The imaginaries represent possible sustainable futures for Europe in 2050. Similarly to today, the production and consumption systems that make life possible within each imaginary are deeply intertwined. This subsequently means that interventions in one system will inevitably affect the others in multiple ways. Systemic properties such as non-linear dynamics, rebound effects, lock-ins, trade-offs and shifting burdens can lead to emergent dynamics between systems. For this reason, cross-system dynamics play an important role in the transformation of production and consumption systems. They must therefore be accounted for in sustainability governance and policy formulation.

To better anticipate possible future system interactions, this section outlines key connections and interdependencies between production and consumption systems that emerged from the imaginary analysis and which represent important areas of governance and policy intervention. The system interactions presented here are, however, by no means exhaustive. In addition, their nature is highly dependent on contextual factors that may vary, depending on the specific setting or situation.

### *Multifunctional land use*

Land is a finite resource. Across all imaginaries, competing land uses highlight difficult trade-offs between different land use needs and policy targets. Examples include the unintended consequences of energy decarbonisation strategies for food security, or of intensive agriculture for soil health, biodiversity and ultimately for the resilience of agro-food systems. At the same time, multifunctional land use practices such as agrivoltaics, agroforestry, or agroecology, offer mixed use approaches. These have the potential to offer synergies between uses and therefore alleviate some of these tensions. Land use strategies that focus on multifunctionality and the delivery of multiple benefits invite an acknowledgement of complexity and the need to adopt a systems thinking approach which is essential for the effective governance of land resources.

### *Urban planning*

Urban areas are expected to be sites of major changes to support food, energy and mobility system transformations, climate change mitigation and adaptation strategies. They are also anticipated to bring nature closer to people through blue-green infrastructure ([7]) and nature-based solutions ([8]). Most imaginaries describe cities acting as major hubs for the production and consumption of energy and food. The role of urban planning in transforming the mobility system, enabling circular economies and supporting increased self-sufficiency and autonomy demonstrates its critical importance.

### *Digital monitoring and automated optimisation systems*

While each imaginary presents a different perspective on how societies might choose to further digitalise, they are consistent in their reliance on digital services for the efficient functioning of multiple systems. Digital technologies are thus often seen as a key enabler of cross-system coordination. An example demonstrating this interaction is relying on digital services to coordinate the mobility of people, food and

([7]) 'A strategically planned network of natural and semi-natural areas designed and managed to deliver ecosystem services' (EEA, 2020b).
([8]) 'Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions' (EC, 2025c).

other goods in a circular economy, while simultaneously bolstering energy efficiency in support of decarbonisation. All systems are implicated in the material and energy investments required to deploy these digitalisation advances and integrate them across urban and rural settings.

### *Cross-system innovation and circularity*

Each imaginary references the development and deployment of technological advances as part of the required system transformations and thus positions innovation ecosystems as a key component of their respective realisation. Innovations that can help close loops in a circular economy or utilise waste from one system as feedstock for another system, are the type of cross-system developments that can be incentivised, albeit using different instruments according to each imaginary's social governance systems. Identifying technologies and other innovations that sit at key inter-system connections and targeting a research agenda towards those innovations or innovation portfolios could foster important advances that are resilient in several futures.

### *Behavioural change*

Consumer behaviour is another critical nexus point in all imaginaries. This is because systems of production and consumption are impacted by the types and patterns of consumer choices. Sustainability requires a change of values. For instance, a cultural shift towards healthier, plant-based diets impacts food systems (agricultural practices and food processing) as well as energy systems (available land for biofuel production). Similarly, consumer mobility choices are affected by the types of energy systems in place and the built environment decisions resulting from urban designs.

### *Localised redundancy and support*

Creating redundancy for core production and consumption systems bolsters resilience. Involving local communities in the planning of support systems that ensure food, energy and mobility remain available in the face of disruptions, can also bolster efficiency and exchange between systems during non-disrupted times. A good example of this is the production of food and energy within urban areas. Such production can supplement larger operations during non-disrupted times and can also produce necessary goods during emergencies or disruptions like energy shortfalls.

# 5 Imagining sustainable futures in the light of future disruptions

In a rapidly changing world defined by high uncertainty, future disruptions are a useful tool to explore and stress-test the plausible positive futures depicted in the imaginaries. This helps generate knowledge on important vulnerabilities and response capacities that can in turn help build resilience for sustainability in Europe. In this context, a disruption represents a plausible extreme development in Europe or worldwide that could, if it came about, markedly change the policy landscape. This chapter delves into the impacts of possible future disruptions in the four imaginaries of 2050. This exploration was conducted considering the core assumptions inherent to the narratives of the imaginaries (see Table 5.1 and Chapter 3).

**Table 5.1 Summary of the core assumptions underpinning the narrative of each imaginary**

| Imaginary | Core assumptions |
|---|---|
| **Technocracy for the common good** | The functionality and stability of digital operations rely on resilient systems, effective data sharing and secure AI deployment. State governance relies on strong top-down regulatory frameworks and instruments. Positive citizen-government relations depend on an acceptance of rules and a commitment to social equity. |
| **Unity in adversity** | A commitment to solidarity emphasises inter-regional support for resource distribution and aims to reduce wealth disparities while enhancing social equity. |
| **The great decoupling** | Sustainable yet consumption-oriented lifestyles rely on the affordability of consumption, and social and political stability, alongside trust in markets. |
| **Ecotopia** | Nature has an intrinsic value and deserves protection rather than being seen merely as a resource for human use. Power is decentralised to local civil actors who can effectively address community needs, fostering a strong community spirit and a focus on reducing inequality. |

Source: EEA.

From a set of future disruptions covering the STEEP domains, two to three disruptions were selected per imaginary (see Table 5.2). For a detailed description of the disruptions and the methodology used in their selection, please see Annex 3.

**Table 5.2 Future disruptions explored per imaginary**

| Imaginary | Possible future disruptions | | |
|---|---|---|---|
| **Technocracy for the common good** | Massive breakdown of digital systems in Europe. | Absence of peace worldwide. | Paralysis of Europe's public sphere. |
| **Unity in adversity** | Uninhabitability of large areas worldwide. | Absence of peace worldwide. | Collapse of trust in EU governance. |
| **The great decoupling** | Global financial crisis 5.0. | Absence of peace worldwide. | |
| **Ecotopia** | Public health crisis worldwide. | Absence of peace worldwide. | Climate disasters in Europe. |

Source: EEA.

In an age of polycrisis, it is likely that multiple disruptions occur simultaneously and influence each other. Therefore, for each imaginary, the potential consequences or impacts of the simultaneous occurrence of these future disruptions were also examined.

## 5.1 Technocracy for the common good

### *5.1.1 Impacts of the disruption: massive breakdown of digital systems in Europe*

#### *Threats to the systems of provision*

In this imaginary, the collapse of digital systems and information flows would hinder the operation of essential infrastructure across all production and consumption systems. This breakdown could lead to significant shortages and price increases for consumer goods, resources, commodities and critical materials. This would result in an economic slowdown and serious impacts on life quality, including limited food, energy and mobility.

#### *Dissolution of state-society relations*

The collapse of civil digital communications — for example, news, media and social platforms — would erode trust in governing institutions, threatening state control and authority. Conflicts could escalate, exacerbated by broken systems of provision (see above), which could lead to widespread discontent and protests. Simultaneously, the failure of data-driven governance could foster social polarisation and erode the foundations of societal cohesion and state-society relations.

### *5.1.2 Impacts of the disruption: absence of peace worldwide*

#### *Failure to deliver on environmental sustainability and social welfare*

The conflict conditions would shift governing priorities from sustainability and social welfare to security and defence. As a consequence, environmental goals would be missed and climate adaptation stalled. Trust in the state to deliver on its promises would also be undermined. Public resources would be primarily spent on keeping digital systems and production and consumption systems semi-functional; this would degrade social and health care and make social cohesion more difficult.

#### *A defence-oriented society and systems planning*

In general, European populations are untrained and mentally unprepared for warfare. This means that deep socio-cultural changes would be needed. This puts pressure on the EU's governance and development mechanisms, which designed production and consumption systems for an era of peace. Sectors that fail to develop adequate responses to conflict conditions could fall under the direct operational range of military control.

#### *EU democracy and social cohesion crisis*

European citizens would increasingly look to leaders that promise to protect them. This would result in the emergence of authoritarian social governance structures, militarised controls, more tightly regulated norms and allowances, and conscripting organisations. Control societies may close national borders and restrict entry of those fleeing conflict areas. Worse, state responses and social conditions would diverge and public support for the EU dwindle, further destabilising social cohesion.

#### *5.1.3 Impacts of the disruption: paralysis of Europe's public sphere*

##### *Social fragmentation and political frustration*

Polarisation on different political issues would lead to social fragmentation. This would extend into many subcultures and interest groups with divergent goals and limited interfaces for deliberating towards decisions. This fragmentation could fuel the destabilisation of unity and democracy, making it difficult to pursue coherent agendas on common social welfare goals. Withdrawn trust in governance and weakened institutions would create more social dysfunction and ultimately destabilise state governance.

##### *EU at risk of losing global impact*

On a global level, the EU would be at risk of stagnation in comparison to other more decision-ready regimes. Europe and its Member States could fail to remain economically competitive during an era of disruptive conflicts. This could encourage Member States to seek other alliances. Fragmentation and disengagement would create the risk of a vicious cycle of maladaptive and unsustainable governance 'solutions', stagnant innovation and degraded EU influence on the global stage.

#### *5.1.4 Impacts of co-occurrence of disruptions*

In a scenario where there is an absence of peace worldwide, a breakdown of digital systems and a paralysis of Europe's public sphere, basic infrastructure and essential supply systems could collapse, leaving local organisations to handle provision of basic goods and services. This might lead to competition for limited resources and make effective, top-down resource management impossible. If the absence of global peace coincides with a paralysis of the public sphere in Europe, issues surrounding the environment and sustainability could be sidelined and authoritarian planning and governance models might find public support. In turn, tensions within the EU could escalate, ultimately leading to a crisis of democracy and cohesion within the EU.

### 5.2 Unity in adversity

#### *5.2.1 Impacts of the disruption: uninhabitability of large areas worldwide*

##### *Erosion of social solidarity*

The uninhabitability of large world regions could weaken social cohesion and the solidarity underpinning the EU. Firstly, displaced populations would erode economic stability, strain public finances and generate inequality, while intensifying pressure on infrastructure, resources and services. Calls for higher military spending may further strain budgets and erode trust. Rising populations in habitable areas could prompt regions to adopt immigration policies misaligned with the EU. This could potentially fracture trust in the EU's governance and create a cycle of diminishing social cohesion and solidarity.

##### *Threatened inter-regional support systems*

The stability of inter-regional support systems would be undermined as uninhabitable land expands and fertile areas diminish, reducing food production and straining European solidarity. Persistent food scarcity in some regions may create a one-sided flow of resources from productive areas to non-productive ones, undermining trust built on reciprocity. Population shifts within the EU could place further pressure on resources and ecosystems.

#### *Rising energy demands in a shrinking agricultural landscape*

Shifting populations, concentrating in habitable areas, would place new energy demands on limited infrastructure for electricity generation and distribution. Limited food supplies would require more energy for transport, despite a diminished biofuel supply, while food production may need to rely on more energy-intensive urban/vertical farming operations. Additionally, solar energy systems could become less effective or unusable in uninhabitable areas due to unfavourable climate conditions.

### *5.2.2 Impacts of the disruption: absence of peace worldwide*

#### *Undermined adherence to EU authority*

Heightened military spending would disrupt public investment in essential systems that maintain the standard of living, increase financial instability and disproportionately affect vulnerable populations. Declining living standards could push regions to act independently, eroding EU solidarity as socio-economic divides are exploited by political actors. As a result, the EU's credibility would be undermined and its ability to uphold social obligations questioned.

#### *Threats to energy and infrastructure*

Global conflicts would disrupt supply chains for essential resources like critical raw materials, fuel, fertilisers and biomass. This would limit energy availability and drive up costs. Consequently, the EU's agricultural energy needs would be constrained and efforts to expand alternative energy infrastructure would be hampered. Rising energy prices would weaken EU economic competitiveness and cyberattacks on critical digital infrastructures, such as water, energy and food, could cause severe societal disruptions.

#### *Eroding the EU's sense of solidarity*

Global tensions could undermine EU unity with misinformation campaigns leading to distrust as rising living costs foster insecurity and inter-regional mistrust. Tax refusals due to economic hardship could reduce public funds needed to support social equity. Additionally, refugee influxes would reopen societal divides and threaten the EU's commitment to mutual support and a sustainable, equitable society.

### *5.2.3 Impacts of the disruption: collapse of trust in EU governance*

#### *Collapsing public services erodes citizen trust in authorities*

If declining trust in EU governance disrupts services, negative citizen experiences could increase distrust, creating a vicious cycle that erodes social solidarity. Failing to equitably provide essential goods would deepen existing inequalities and worsen socio-economic disparities. These dynamics would drive social pressure toward alternatives to EU authority and allow private actors to exploit communities, further undermining European principles of sustainability and social solidarity.

#### *Increasing local and regional autonomy undermines EU authority*

The central role of EU authorities in managing the development and maintenance of a sustainable and equitable society would be undercut by collapsing public trust that encourages local and regional authorities to increase their autonomy. This would make the inter-regional support systems unreliable and encourage further

unilateral decisions by European regions and local areas. Rising nationalism in some parts of the EU and regional sovereignty would further fragment European nations and regions.

#### *5.2.4 Impacts of co-occurrence of disruptions*

If two, or even all three, of these major disruptions happened at the same time, a significant concern would be the securitisation of environmental issues and responses. As habitable areas diminish and conflicts escalate in various regions, the EU's stringent stance on environmental health and security may lead to the dismantling of environmental projects on sustainability goals. Additionally, the competition for critical raw materials may evolve into a more violent struggle and complicate the EU's ability to assert a neutral stance in external conflicts. Another concerning development would be the emergence of informal localised security forces that border on vigilantism fuelled by disruptions that foster division and fragmentation within the EU. In situations where the EU lacked the capacity to effectively intervene with these groups, they would pose a significant threat to social cohesion and stability.

Food security is another critical vulnerability of this imaginary, emerging from all these disruptions and indicating that the EU's food system is susceptible to numerous adverse influences. This vulnerability also serves as a key driver of change, impacting other interdependencies within the EU, such as solidarity, inter-regional support and governing trust.

Given the 'Unity in adversity' imaginary's dependency on Member State cooperation and cohesion, if Member States moved towards a more insular mindset, focusing narrowly on national interests rather than the collective well-being of the EU, a vicious cycle could emerge. This could further erode solidarity and cohesion within the EU.

### 5.3 The great decoupling

#### *5.3.1 Impacts of the disruption: global financial crisis 5.0*

##### *Social disparities and loss of trust in democratic systems*

A global financial crisis would threaten social and political stability by widening social disparities and undermining trust in democratic systems. Hyperinflation might increase poverty, make sustainable consumption unaffordable, deepen the wealth gap and risk social unrest. Furthermore, limits to both private and public investment in education and innovation could weaken the EU's knowledge-based economy and global competitiveness. A diminished tax revenue would strain democratic governments and further erode social cohesion in a knowledge-driven society.

##### *Erosion of talent, skills and mental health*

Reduced investment in education, research and innovation could lead talented individuals to migrate to more attractive places to work. As a result, fewer people would be trained and a shortage of key skills would develop (or aggravate). Economic growth would shrink in the long term, exacerbated by a loss of qualified and innovative labour. This would undermine the cornerstone of this imaginary: technological progress for a sustainable and competitive economy and society in a globalised world.

#### *Erosion of financial systems and fiscal space to respond to a financial crisis*

The ongoing exploitation of regions rich in raw materials could escalate the post-financial crisis, intensifying public disapproval and fuelling extremism. This response could be exploited by populist and autocratic regimes to justify protectionism, as well as restrict resource supply, trade and access to skilled labour and migration. Protectionist measures, particularly by the USA and China, would limit market access for European companies. As a result, these companies' need for state support would increase, even as EU Member States face dwindling financial resources and are engaged in a subsidy race that weakens their competitiveness.

### *5.3.2 Impacts of the disruption: absence of peace worldwide*

#### *Lack of fiscal space to respond to the economic impacts of the absence of peace*

Increased defence spending would place a long-term burden on public budgets and reduce the financial scope for other areas and policies. Consequently, research and innovation, social welfare and education investments and industrial subsidies would be impaired. This would jeopardise key cornerstones of green growth in this imaginary. Instead, the focus of investment would be on defence, civil protection and dual-use technologies.

#### *Decline of EU solidarity, commitment to shared action*

The concentration of investments in military armament and civil defence could lead to a change in industrial structures, with the defence sector claiming priority across key industries such as information and communication technologies (ICTs) and mobility. As some industrial sectors lose relevance, country alliances within the EU would change depending on powerful state influence. States' self-interest would become a top priority. The fear of a world war would become an important driver of government decisions, where commitment to EU solidarity and joint action could decline.

#### *Economic collapse slows down innovation*

In this imaginary, the EU is not autonomous in terms of security and defence and the economic collapse triggered by conflict could result in blocked access to essential components produced abroad, such as semiconductors. This would set back Europe's ability to innovate and significantly slow down economic growth, resulting in falling tax revenues despite a rise in defence spending.

### *5.3.3 Impacts of co-occurrence of disruptions*

In the context of 'The great decoupling' imaginary, the compounded disruptions of a persistent global financial crisis and the widespread absence of peace could set off a chain reaction across Europe, deepening economic and social divides. As Europe grapples with ongoing financial instability, there would be a palpable shift in public spending away from social and environmental investments towards heightened defence budgets. Such a priority shift, aimed at responding to external and internal security threats, would undercut commitments to sustainability and push environmental objectives further down the policy agenda.

In this climate of austerity and fear, economic insecurity could fuel polarisation within European societies, promote narratives of scarcity and exclusion, and intensify the internal cultural conflicts. As Europe contends with a rising number of displaced

individuals seeking refuge from conflict or climate upheaval, social cohesion would suffer, aggravating existing inequalities and entrenching nationalist and populist stances across the continent.

The absence of a unified approach to both economic and social resilience would threaten Europe's global competitiveness and diminish its standing as a destination for skilled labour. Attempts to implement cohesion policies could be easily undermined by divisive politics, rendering the vision of a unified Europe more elusive. The confluence of financial and security priorities, compounded by fragmented solidarity, would challenge Europe's ability to act as a haven for diversity and pluralism. Europe could thus find itself at a critical juncture, caught between the urgent need for security and the enduring vision of sustainability, inclusivity and social justice.

## 5.4 Ecotopia

### *5.4.1 Impacts of the disruption: public health crisis worldwide*

#### *Insufficient coordination*

Insufficient coordination of European medical research and innovation could diminish the EU's capacity to respond effectively to a public health crisis. This could consequently lead to delays in detecting disease outbreaks and securing essential medication, such as vaccines, impacting vulnerable populations the hardest. This would put stress on healthcare systems and affect the availability of the labour force and consequently production capacities, resulting in a greater competition for goods. Regional coordination issues could undermine community cohesion and jeopardise the bedrock of Ecotopia's society — shared social values.

#### *Affected social cohesion and rising isolationism*

The cohesion of communities would be threatened by a global health crisis, resulting in heightened border protection and growing isolationism. Intensified intra-European conflicts over resources could revive old borders (both national and subnational) within Ecotopia. Due to the differing impacts of crisis on various age groups, advocates arise promoting a greater acceptance of death via 'natural selection'. This risks the rise of autocratic tendencies and a loss of solidarity.

### *5.4.2 Impacts of the disruption: absence of peace worldwide*

#### *Values in conflict*

The absence of peace worldwide could create deep unrest within Ecotopia, as its foundational values would face intense scrutiny. As external conflicts escalate, Ecotopia would feel increasingly isolated and vulnerable to potential invasions or aggression. The erosion of shared values and community solidarity could open the door to misinformation and manipulation, deepening divisions and complicating efforts to find common ground amidst the turmoil.

#### *Economic and ecological strain*

As resources shift to defence and security, higher living costs and restricted access to resources could lead to a lower standard of living. War-driven environmental damage would impact natural habitats and agricultural systems, resulting in food shortages, polluted water and soil and elevated threats to public health and

ecosystem stability. Attacks on infrastructure and cyber-attacks could destabilise the economy and weaken internal supply chains, as Ecotopia risks spiralling into chaos.

### *5.4.3 Impacts of the disruption: climate disasters in Europe*

#### *Coastal infrastructure damage and health challenges*

The loss of productive land and infrastructure due to rising sea levels, intense storms and habitual flooding could reduce the overall economic output of coastal regions. This could force residents to abandon coastal communities in search of safer and more viable living conditions. Saltwater intrusion into freshwater supplies would render many traditional sources of drinking water unusable, leading to conflicts over water access and increased risk of waterborne diseases.

#### *Economic decline and food shortages*

Climate disasters could precipitate economic decline and exacerbate food shortages, posing significant challenges to local livelihoods and food security. Farmers could face mounting challenges from shifting precipitation patterns, land degradation and biodiversity loss. These could lead to crop failures and reduced agricultural yields.

### *5.4.4 Impacts of co-occurrence of disruptions*

If the three disruptions — a global public health crisis, widespread absence of peace and climate disasters in Europe — were to occur simultaneously in Ecotopia, they would exacerbate one another in both speed and intensity. The consequences would include a rise in isolationism and a loss of trust in Ecotopia's foundational values and beliefs, such as social cohesion, solidarity and appreciation of nature. This breakdown would undermine the sense of community that is vital to Ecotopia's identity and threaten the short- and long-term health and wellbeing of European citizens.

Moreover, the health of biodiversity and nature would be at risk, potentially leading to irreversible tipping points that could inflict permanent damage on ecosystems. Such ecological devastation would likely result in a reduction of both available food and potable water, as well as societal depression, stemming from a profound lack of hope. These results would foster further isolationism, eroded community values and diminished cohesion, thus threatening the foundation of Ecotopia.

## 5.5 Cross imaginary analysis of overarching vulnerabilities

Future disruptions may exert diverse impacts on social, economic and ecological systems, as conceptualised within the logic of the four imaginaries. While each disruption introduces unique challenges, overarching vulnerabilities and interdependencies can be identified that mutually influence and amplify one another. The imaginaries share critical weaknesses in their capacity to respond to large-scale and sudden disruptions. These vulnerabilities arise primarily from complex inter-dependencies between production and consumption systems, wherein small failures might cascade and combine to create a progressive erosion of social trust and societal cohesion, threats to democracy and critical infrastructure. Such vulnerabilities necessitate the development of societal capacities as well as resilient and adaptive strategies that address both local and transregional dimensions to safeguard the foundations of solidarity, democracy, environmental, social and economic sustainability.

### *Threats to social cohesion through social and economic inequalities*

Global disruptions, such as financial collapses, climate catastrophes, or the absence of peace, exacerbate inequality, polarisation and social unrest. Vulnerable populations are disproportionately affected by rising prices, declining incomes and the erosion of social safety nets. Increasing competition for scarce resources threatens solidarity mechanisms at both local and regional levels. In the face of disruptions, the cross-imaginary analysis highlights a rise in isolationism and individualism, which constrains the ability to solve problems collectively. A decline in global and regional cooperation could further weaken resilience against systemic shocks. The loss of community, social connectedness, trust and security contributes to demands for more authoritarian and centralised governance structures across multiple imaginaries.

### *Threats to democracy and governance*

The rise of authoritarian structures poses risks of power abuse and undermines fundamental democratic principles. Across several imaginaries, disruptions may lead to governance fragmentation, triggered by varying challenges. A lack of cohesive strategic alignment at the EU level could jeopardise Europe's political unity, thereby limiting its ability to address transboundary challenges such as climate change and biodiversity loss. The combination of disruptive events, misinformation and poor coordination diminishes trust in political and institutional authorities. As a result, local or alternative power structures may gain influence, further weakening social cohesion.

### *Threats to critical infrastructure and digital systems*

Heavy reliance on digital and technological networks increases the risk of severe disruptions in multiple imaginaries due to system failures. These disruptions could critically affect not only economic processes but also essential supply structures, including energy, water and food. Resource depletion and the loss or degradation of ecological systems, exacerbated by conflicts, hinder long-term sustainability goals in several imaginaries. In crisis scenarios in the logic of the four imaginaries, environmental concerns are often deprioritised in favour of immediate security and economic needs, delaying climate goals and intensifying ecological damage.

# 6 Towards a sustainable future

In moving toward a sustainable Europe by 2050, it is clear that European production and consumption systems will and must be fundamentally transformed. The scope and scale of such broad system changes makes it difficult to form a mental representation of a radically different future. In addition, since each of the systems might be changed in several ways, the number of possible futures to consider becomes impossible to manage.

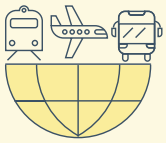
The imaginaries (EEA, 2022a) provide four different lenses through which to explore possible configurations of sustainable core production and consumption systems within Europe in 2050. As presented in the previous chapters, each imaginary offers insights into how food, energy, mobility and built environment systems might be transformed in terms of production, consumption and equitable access to products and services.

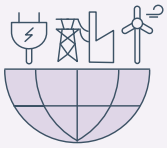
Even though the imaginaries depict Europe in 2050, the purpose of exploring different futures is to inspire and inform the decision-making processes of today. To help today's social actors create a more desirable and sustainable future, this chapter offers a summary of the insights produced with respect to the transformation of core production and consumption systems towards sustainability (see Figure 6.1). Those insights have been organised into two distinct categories. First, the areas of transformative potential within each system, albeit non-exhaustive, outline where actions might be focused today, to facilitate or catalyse transformative change towards a sustainable Europe in 2050 (see Chapter 6.1). Second, a set of capacities for transformative change is put forward across different thematic areas that can strengthen society's ability to navigate processes of systemic change towards long-term environmental and socio-economic goals and build societal resilience in the light of external shocks (see Chapter 6.2).

**Figure 6.1** **Areas of transformative potential and capacities for transformative change**

**Areas of transformative potential**

| Food system | Mobility system | Built environment system | Energy system |
|---|---|---|---|
| Shift to sustainable protein sources | Decarbonised mobility | Redesign, repurposing and renovation of existing buildings | Renewable and locally available energy |
| Local food production | Multimodality and public transport infrastructure | Integration with natural ecosystems | Decentralised energy production |
| Regenerative land use | Connected and automated mobility infrastructure | Technological innovation and digitalisation | Energy efficiency and demand management |
| Integration of digital technologies | Accessible and affordable mobility | Affordable housing and social cohesion | Integration and modernisation of energy networks |
| Accessible nutritious and healthy food | | | Accessible clean and affordable energy |



**Capacities for transformative change**

| | | | |
|---|---|---|---|
| **Collaborative and anticipatory governance** | Collaborative multilevel governance<br>Anticipatory governance | Adaptive and inclusive governance frameworks<br>International cooperation and multilateralism | Global citizenship and solidarity |
| **Societal engagement and creativity** | Engagement of citizens in decision making | Engagement of organised civil society in decision making | Human creativity and innovation |
| **Connection to nature and empathy** | Deep connection to nature | Education for empathy and collective well-being | |
| **Spatial planning and multifunctional land use** | Spatial and urban planning | Multifunctional land use | |
| **AI and digitalisation** | Safe and trustworthy AI deployment for the public good | Technological independence and resilience in digital infrastructure | |
| **Preparedness for shocks** | Futures literacy and foresight<br>Resilient public care and education infrastructure | Financial buffering and sustainable investment<br>Self-sufficiency at the local level | Disaster preparedness and community training<br>Collective memory and learning from past experiences |

**Source:** EEA.

## 6.1 Areas of transformative potential within core production-consumption systems

By analysing the changes outlined for each imaginary, areas where actions have the potential to transform core production and consumption systems towards sustainability begin to emerge. These exhibit one or more of the following traits:

- catalyse deep changes within multiple imaginaries;
- display impacts on multiple systems;
- applicable to multiple European regions.

### *6.1.1 Food system*

#### *Shift to sustainable protein sources*

A dietary shift towards alternative protein sources, including plant-based and cultivated meat products, is promoted across most imaginaries due to perceived environmental, health and dietary benefits. Such shifts are seen as opportunities to decarbonise the food system, innovate across the food supply chain, and contribute to food security. Beyond policy instruments, some imaginaries emphasise the role of education for sustainable eating to facilitate the adoption of healthy food habits and promote healthier food options.

#### *Local food production*

Despite differing approaches, several imaginaries display a strong focus on regional and local food supplies to improve self-sufficiency and strengthen regional and local economies. Practices such as urban agriculture, local cooperatives and shorter supply chains are prevalent and play an important role in fostering social cohesion and supporting ecosystem services, such as pollination, temperature regulation, water and air purification.

#### *Regenerative land use*

Regenerative land use practices such as agroforestry and agroecology play an important role in the sustainability of food systems across the imaginaries. These practices improve soil health, promote biodiversity, increase carbon sequestration and reduce GHG emissions, in addition to producing goods with market value.

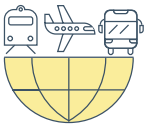
#### *Integration of digital technologies*

Technologies such as precision agriculture, AI and digital monitoring are essential tools in food production and distribution in most imaginaries. These systems enable more efficient farming methods, optimised resource use and reduced environmental impacts. Data-driven pricing controls and personalisation of nutrition are also widespread, guiding consumers towards healthier eating.

#### *Accessible nutritious and healthy food*

Promoting universal access to safe, nutritious and healthy food involves the inclusive transformation of multiple aspects of food systems and food value chains. The imaginaries present a variety of mechanisms to ensure everyone has access to healthy food. These include market interventions to ensure fair pricing structures and support small-scale producers and retailers; producer or consumer subsidies, as

well as incentivising research and innovation (R&I) in food system operations. They also involve creating and maintaining strategic reserves and distribution networks for emergencies and promoting regional self-sufficiency through support for smaller agriculture and food manufacturing as well as processing operations.



### 6.1.2 Mobility system

#### Decarbonised mobility

Emission-free vehicles and the use of renewable energy across all transport modes have become the standard across the imaginaries. Governmental and community-based initiatives such as carbon budgets, local taxes and carbon credit systems are promoted to support these goals. Additionally, transport infrastructures are designed to reduce not only GHG emissions but also the emission of air pollutants and noise. The decarbonisation of mobility is also assumed to include a reduction in vehicles (especially automobiles) and/or a reduction in the overall mobility demand.

#### Multimodality and public transport infrastructure

Multimodality and public transport infrastructure are at the forefront of the transformation of EU mobility in all imaginaries. Attractive, seamless intermodal transport connections that integrate various modes of transport make mobility more efficient and collective. Public transport and shared mobility services increasingly replace private vehicles and short-haul flights, while pedestrian and cycling traffic, along with mobility-as-a-service (MaaS) solutions, are promoted. The development towards '15-minute cities' reduces mobility needs while decentralised mobility hubs facilitate access to mobility services in all regions.

#### Connected and automated mobility infrastructure

Digital platforms and automated systems optimise traffic flows and improve safety, accessibility and interoperability of mobility services in most imaginaries. Digitalisation also improves efficiency in logistics and the movement of goods in an energy efficient manner through digital control centres.

#### Accessible and affordable mobility

A range of financial and non-financial measures that foster social equity, address transport poverty ([9]) and support access to mobility for all, including disadvantaged groups, come through the imaginaries. These include measures to ensure the availability of transport networks that meet existing mobility needs. They also include measures such as subsidies and tiered pricing models to ensure transport affordability, particularly in rural or infrastructure-poor areas. Measures to improve digital skills and ensure everyone has access to digital communications are also included.

([9]) Transport poverty refers to 'individuals' and households' inability or difficulty to meet the costs of private or public transport, or their lack of or limited access to transport needed for their access to essential socioeconomic services and activities, taking into account the national and spatial context' (EU, 2023a).

### 6.1.3 Built environment system

#### Redesign, repurposing and renovation of existing buildings

The importance of redesigning, repurposing and renovating existing buildings is emphasised in all imaginaries as strategies to extend the lifespan and utility of the existing building stock and consequently reduce resource use and GHG emissions across the building life cycle. Comprehensive renovation measures increase energy efficiency, extend the lifespan of buildings, increase disaster resilience and improve health conditions ([10]). Innovative approaches towards modular construction, material reuse and recycling and the integration of novel materials — including bio composites made from renewable resources and other bio-based materials — promote circular economy models and foment innovation.

#### Integration with natural ecosystems

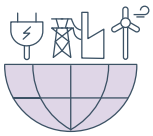
Human settlements increasingly integrate with natural ecosystems in all imaginaries. There is a strong effort to create and give more space to blue-green infrastructure that offers both ecological and social benefits and contributes to climate mitigation and adaptation. These integrative approaches help to improve human health and wellbeing and promote biodiversity in urban areas ([11]).

#### Technological innovation and digitalisation

The use of digital technologies to monitor and optimise building performance is present in most imaginaries. Intelligent systems collect real-time data on energy and resource use to enhance efficiency, occupant comfort, ensure building maintenance and promote environmentally friendly behaviours.

#### Affordable housing and social cohesion

The redesign of the built environment and the repurposing and renovation of existing properties is promoted in all imaginaries to create living spaces, mixed-use areas and provide to access to essential services. Access to liveable and affordable housing is ensured through targeted government interventions and funding mechanisms. Mixed-use areas that combine housing, work and leisure activities support integration and ownership and foster social cohesion ([12]).



### 6.1.4 Energy system

#### Renewable and locally available energy

The need to eliminate the dependence on fossil fuels is highlighted in all the imaginaries. The focus instead is on the development and increased deployment of renewable energy production systems using wind, solar, biomass, geothermal and other locally-available renewable energy sources. Nevertheless, the manufacture of 'net-zero' technologies requires ensuring that secure and sustainable supply chains are in place for clean energy infrastructure.

([10]) More information about building stock renovation can be found in Gkatzogias et al. (2023) and Maduta et al. (2022).
([11]) More information about socio-inequalities in the access to urban green and blue spaces across Europe can be found in EEA (2022c).
([12]) In 2020, the EC launched the New European Bauhaus (EU, 2025) policy and funding initiative, aiming to create beautiful, sustainable and inclusive places, products and ways of living. A self-assessment method and tool (Lourenço et al., 2024) helps professionals assess these three dimensions in buildings and living spaces.

### *Decentralised energy production*

There is a significant shift towards decentralised energy production systems to foster the resilience of energy systems, improve energy access and affordability. Local energy communities and networks emerge in various imaginaries, tailored to the specific needs of their respective regions. These local systems promote self-generation and storage of energy and enhance the self-sufficiency of communities.

### *Energy efficiency and demand management*

A continuous drive to improve energy efficiency, both at the consumer level and in industrial processes features in all the imaginaries. Technological advancements, including smart meters and automated control systems, are utilised to monitor and manage energy consumption. Demand management becomes crucial to ensure a balance between supply and demand and to minimise energy waste.

### *Integration and modernisation of energy networks*

The modernisation and integration of energy distribution networks are essential prerequisites for a sustainable energy system in all imaginaries. This includes the expansion of smart grids that enable more efficient distribution and transport of energy. Energy networks are designed to integrate renewable energies more effectively into the existing infrastructure, optimising energy flow and increasing system stability.

### *Accessible clean and affordable energy*

Eliminating energy poverty ([13]) is a fundamental goal in all imaginaries. There are a number of ways this can be done — by reducing households' energy needs, for example via thermal insulation, efficient heating and cooling systems; by reducing external energy dependency, for example via solar energy generation and also by providing access to affordable and reliable clean energy for all. Promoting social justice and protecting disadvantaged groups are central to ensuring that all citizens benefit from the energy transition. Across the imaginaries this is achieved through a range of supportive measures, financial and non-financial. Examples of these measures include reduced tariffs, cash benefits, grants, public investments, equitable distribution systems as well as measures that protect people in vulnerable situations from being disconnected such as advisory and support services ([14]).

## 6.2 Capacities for transformative change

In using the imaginaries of 2050 to gain different perspectives on the potential transformations of core production and consumption systems in Europe as well as insights about how Europe might respond to future disruptions, important questions remain. How might Europeans act today to continue moving Europe towards a sustainable future? How can the results of this foresight report inform and guide actors across society who aspire to make sustainable futures both desirable and resilient?

([13]) The revised Energy Efficiency Directive (EU, 2023b) defines energy poverty as 'a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting and energy to power appliances (…) caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes'.

([14]) For more information on unaffordable housing, please see Eurofound (2023). To find out more about access to essential services, please see Eurofound (2022).

In light of the analysis underpinned by the four imaginaries, this final section examines capacities in a number of areas that, if developed, can help society to navigate processes of systemic change towards long-term environmental and socio-economic goals and build transformative resilience. Transformative resilience is understood here as the capacity of systems in transformation to successfully deal with major changes and move towards long-term goals despite (or even because of) system stresses, sudden shocks or crises (EEA, 2024a).

Although the imaginaries provided very different conditions for system transformations to unfold, the needed capacities they point towards share some common traits. These can be grouped according to the following thematic clusters:

- collaborative and anticipatory governance;
- societal engagement and creativity;
- connection to nature and empathy;
- spatial planning and multifunctional land use;
- AI and digitalisation;
- preparedness for shocks.

### *6.2.1 Collaborative and anticipatory governance*

#### *Collaborative multilevel governance*

Collaborative multilevel governance ([15]) networks can support coherent, effective and efficient policy and decision-making between different government levels — supranational, national and sub-national — and a multiplicity of actors. Adopting inclusive and participatory approaches promotes both unity and autonomy. It also enhances vertical and horizontal collaboration and improves decision-making at the local level, which can prove essential during large-scale disruptions. Ensuring interconnectivity across Member States further strengthens Europe's adaptive capacity, enabling support across regions based on needs.

#### *Anticipatory governance*

Anticipatory governance that systematically embeds strategic foresight into decision-making at different levels is necessary to help prepare for an uncertain future but also to create vivid pictures of a sustainable future to strive towards. Exploring and anticipating possible future developments using strategic foresight promotes long-term thinking and can support policymaking at different stages of the policy cycle, from initial problem scoping to option design, as well as reviewing and futureproofing existing policies.

#### *Adaptive and inclusive governance frameworks*

Inclusive and adaptative governance frameworks ([16]), integrating decentralised decision-making and digital participation tools, can empower actors to engage in

([15]) Governance is defined here as 'the totality of interactions in which government, other public bodies, private sector and civil society participate (in one way or another), aimed at solving public challenges or creating public opportunities' (Meuleman, 2008).

([16]) A governance framework is defined here as 'the totality of instruments, procedures and processes designed to tackle a group of societal problems' (Meuleman, 2014).

decision-making processes that shape policies relevant to their local contexts. Such governance frameworks foster resilience by creating structures and processes that remain adaptable in rapidly changing environments.

#### *International cooperation and multilateralism*

A constructive and proactive approach to strengthen international cooperation and multilateralism is essential to navigate global sustainability challenges and threats that transcend national borders. Cooperation in the form of financial support for sustainability measures and coalitions at the supranational level can help Europe promote shared goals and collective responsibility towards social, economic and ecological sustainability.

#### *Global citizenship and solidarity*

A shared narrative centred on solidarity is essential for European cohesion. Through educational initiatives and programmes, the EU can promote values of solidarity and inclusivity within and beyond national borders. Fostering a culture of global citizenship and responsibility can help counteract nationalist tendencies and help Europe navigate crises collectively as well as build resilience.

### *6.2.2 Societal engagement and creativity*

#### *Engagement of citizens in decision making*

To mobilise the creativity, agency, knowledge and wisdom as well as the ways of knowing needed to navigate sustainability transformations, a better anchoring of citizens in policy and decision-making processes needs to take place. This must go beyond consultation and extend into deliberation and the co-creation of decisions. To do this by default and by design, the existing legal basis for embedding citizen engagement in such processes needs to be strengthened. In addition, enabling institutional capacities and infrastructures need to be developed. Inclusive forms of governance can help connect individuals around shared goals and promote a sense of belonging, ownership, agency and accountability. Mechanisms such as citizen assemblies, participatory budgeting and platforms for community dialogue (online and non-online); as well as formats that go beyond conversation into co-management and co-monitoring, such as experimental spaces for the co-governance of the territory, can help build this. Deliberative and participatory processes promote considered collective judgment and can help counteract polarisation tendencies. Nevertheless, it is essential that such processes are meaningful, inclusive and transparent. Educational programmes for different age groups that foster democratic literacy and individual agency should be promoted. This will help ensure citizens understand and even demand to be involved in decision-making processes.

#### *Engagement of organised civil society in decision making*

In addition to engaging individual citizens, institutionalising the engagement of civil society organisations in decision-making processes throughout the policy cycle is key. This includes social partners representing the interests of workers and employers, NGOs and grassroots organisations. Doing this will ensure distributional, procedural and recognitional justice ([17]), increase legitimacy and transparency and

([17]) The EEA considers three dimensions of justice in sustainability transitions (EEA, 2024e). These are distributional justice (allocation of costs and benefits across society); procedural justice (equal access to and participation in decision-making) and recognitional justice (respect for, engagement with and fair consideration of diverse cultures and perspectives).

also build trust in governance and political institutions. Existing multi-stakeholder partnerships, such as the partnership agreements for the joint implementation of EU cohesion funds, illustrate the potential for leveraging knowledge and expertise as well as strengthening the collective commitment and ownership of EU policies.

#### *Human creativity and innovation*

To navigate sustainability transformations, society needs to leverage creativity and innovation. Encouraging imagination and creative problem-solving allows new approaches to sustainability to be envisioned ([18]). Platforms and other mechanisms that support collaborative creativity can inspire societal actors to develop resilient responses to emerging challenges. Artistic initiatives, storytelling and inclusive cross-cultural co-creation can play a vital role in uniting people and sparking ideas for sustainable living.

### *6.2.3 Connection to nature and empathy*

#### *Deep connection to nature*

Contact and a profound emotional connection with nature are crucial in fostering sustainable mindsets and behaviours, as well as empathy for other human and non-human beings. Environmental education that is transversal (i.e. not domain-specific), lifelong and which fosters immersion and learning in nature is essential for building such an emotional connection and also for understanding nature's importance for the health of the planet and people. It is also important to ensure that all citizens can experience nature, in close proximity, on a daily basis by bringing nature into public spaces — for example in the form of green and blue spaces, nature-based solutions and areas of wild nature. Understanding ourselves as deeply interconnected with and interdependent from nature can encourage a deeper appreciation for nature's intrinsic value. It can also inspire and motivate us to care for and protect nature, rooted in an expanded sense of responsibility that goes beyond utilitarian arguments ([19]).

#### *Education for empathy and collective well-being*

Transversal (i.e. not domain-specific) and lifelong education emphasising empathy, emotional intelligence, individual and collective well-being as well as cooperative problem-solving can foster social cohesion, which is required for sustainability transformations. By fostering a culture of mutual support and understanding from an intercultural, interreligious and intersectional perspective across education, work, leisure and community life, Europe can enhance its social resilience and ability to prepare for, respond to and transform due to major disruptions. This could take multiple shapes. An example is the creation of community spaces where positive content and positive interactions — for example interracial and intergender — can be experienced. However, enabling conditions must be established, such as infrastructures, institutional capacities and a legal basis.

([18]) For more information on the role of imagination as a capacity of transformative agency, please see Moore and Milkoreit (2020).
([19]) Find out more about human-nature relationships via EEA (2023).

### 6.2.4 Spatial planning and multifunctional land use

#### Spatial and urban planning

It is crucial to mobilise and reinforce existing frameworks and instruments for sustainable spatial planning to minimise land-use tensions. These frameworks and instruments can be used to ensure both social and nature positive impacts, such as the integration of green and blue spaces, ecological regeneration and the enhancement of ecosystem services both in urban and peri-urban areas. They can help unlock the potential of underused urban areas to create healthier and more liveable cities that are better adapted to climate change ([20]). Special attention needs to be paid to peri-urban and rural areas, where typically rural or agricultural land is being lost to construction (soil sealing). In this context, public-private partnerships (PPPs) or public-private-people partnerships that include societal actors can open up space for negotiating action towards sustainability, while also leveraging the strengths and resources of different actors.

#### Multifunctional land use

Ways to actively promote place-based multifunctional land use need to be developed. This includes researching and experimenting with innovative approaches to land use that provide both ecological and economic benefits. Increased collaboration among various stakeholders and disciplines is necessary to find sustainable solutions that consider different claims on land use, while also connecting the needs of urban, peri-urban and rural areas.

### 6.2.5 AI and digitalisation

#### Safe and trustworthy AI deployment for the public good

AI has the potential to improve government accountability and transparency and also enhance public participation. As AI becomes increasingly integrated into governance to improve public services and decision-making, ensuring its deployment is both safe and transparent is essential. Mechanisms are needed to ensure that the power of AI is regulated and used for the public good. These include the establishment of regulatory frameworks that guarantee that the use of AI aligns with European values; oversight agencies that are dedicated to AI governance and which enforce strict safeguards against AI misuse; and guidelines to promote transparency and accountability.

#### Technological independence and resilience in digital infrastructure

In a global landscape marked by increasing supply chain vulnerabilities, Europe can benefit from enhancing its technological independence. It can do this by localising critical industries and increasing its control over essential digital and energy technologies. Prioritising investments in R&I within Europe plays a key role in enabling the region to innovate independently and reduce its reliance on foreign technologies. Developing redundancy in critical digital infrastructure — such as decentralised data storage, alternative communication networks and independent supply chains — can help mitigate disruptions. Similarly, embedding backup systems and alternative supply networks within Europe's infrastructure can strengthen its ability to ensure continuous operation during times of crisis.

([20]) Find out more about best practice guidance in EC (2023b).

### 6.2.6 Preparedness for shocks

#### Futures literacy and foresight

Cultivating futures literacy ([21]) and the ability to imagine and explore alternative futures as a collective capacity can enhance both citizens' and organised civil society's ability to anticipate, prepare, respond to, recover from and invent in the face of change and future disruptions. This can be done through a variety of pathways, including education, work and dedicated laboratories, thus strengthening long-term societal resilience ([22]).

#### Resilient public care and education infrastructure

Preventing care needs and maintaining continuity in essential public services, including healthcare and education, is critical to social stability. Partnerships with NGOs can help maintain these services during crises, preventing escalation into poverty and other social issues. Governmental investments in adaptive public service models that ensure basic needs are met and foster a foundation of social stability that sustains communities even through disruptions are needed.

#### Financial buffering and sustainable investment

To maintain economic stability, public finance systems need to be improved with mechanisms that promote resilience and sustainability. Financial buffering, through reserves and wealth taxes, can provide the fiscal space needed to support essential services and invest in innovation. Establishing these financial mechanisms can help manage economic downturns while continuing to invest in education, healthcare and sustainability transformations.

#### Self-sufficiency at the local level

The EU can support and build resilience towards future disruptions by promoting self-sufficiency and autonomy at the local level across different production and consumption systems. These might include off-grid solutions, local markets and mutual aid networks. Civil society actors, such as local organisations and cooperatives, can play an instrumental role in strengthening local governance structures.

#### Disaster preparedness and community training

Localised disaster planning training for preparedness can help prepare communities to respond to environmental crisis. Establishing regional disaster response systems and encouraging knowledge-sharing across regions helps create a support network for rapid response. Community training on risk reduction and resilience will enhance Europe's collective preparedness for climate-related challenges.

#### Collective memory and learning from past experiences

Developing a shared memory of past challenges and responses can provide invaluable insights for future resilience. Communities should actively promote ways to preserve and reflect on collective experiences, using them as learning tools. Memorial projects, documentation and intergenerational knowledge-sharing can serve as a foundation for building a collective understanding. This can inform future decisions and help avoid past mistakes being repeated. This capacity to reflect and remember is a vital resource in preventing crises and ensuring that hard-earned lessons are not lost over time.

([21]) 'Futures literacy' is defined as the capability to understand why and how to 'use-the-future' (UNESCO, 2018).
([22]) More information on futures literacy as a sustainability competence can be found in Bianchi et al. (2022).

# 7 List of abbreviations

| | |
|---|---|
| 3D | 3-dimensional, i.e. 3D-printing |
| AI | Artificial intelligence |
| B2B | Business-to-business |
| B2C | Business-to-consumer |
| BMS | Building management system |
| C2C | Consumer-to-consumer |
| $CO_2$ | Carbon dioxide |
| DIY | Do-it-yourself |
| DG | Directorate-General |
| DSO | Distribution system operator |
| FAO | Food and Agriculture Organization |
| EC | European Commission |
| ECDC | European Centre for Disease Prevention and Control |
| EEA | European Environment Agency |
| EFSA | European Food Safety Authority |
| Eionet | European Environment Information and Observation Network |
| EMSA | European Maritime Safety Agency |
| EU | European Union |
| Eurofound | European Foundation for the Improvement of Living and Working Conditions |
| ETC ST | European Topic Centre on Sustainability Transitions |
| GDP | Gross domestic product |
| GHG | Greenhouse gas |
| $H_2$ | Hydrogen |
| ICT | Information and communication technology |
| IoE | Internet of everything |
| ITS | Intelligent transportation system |
| JRC | Joint Research Centre |
| MaaS | Mobility-as-a-service |
| NGO | Non-governmental organisation |
| OECD | Organisation for Economic Co-operation and Development |
| PPP | Public-private partnership |
| R&I | Research and innovation |
| RES | Renewable energy source(s) |
| SDG | Sustainable development goal(s) |
| STEEP | Social, technological, economic, environmental (including health) and political domains |
| UN | United Nations |
| UNEP | United Nations Environment Programme |

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# Annex 1 Imagining a sustainable Finland in 2050

***By Sanna-Riikka Saarela, Julianna Reunanen (Finnish Environment Institute), Kaisa Välimäki and Roosa Käsmä (Forum for Environmental Information)***

The future of production and consumption systems, including their interactions, depends on local, regional and national conditions. In October 2024, a national workshop took place in Finland to explore and reflect — from a Finish perspective — on the four imaginaries of a sustainable Europe in 2050, as developed by the EEA and the Eionet (EEA, 2022a). The three-hour event was organised by the Finnish Environment Institute, the Ministry of the Environment, the Prime Minister's Office, the Forum for Environmental Information and the Natural Resources Institute Finland. It brought together 32 experts from the public sector, business, research and civil society. All participants received background material in advance to familiarise themselves with the imaginaries and their European interpretations.

After an introduction to the imaginaries, the participants discussed the following questions in system-specific breakout groups:

- What do the results look like from a Finnish perspective?
- What seems to change most in the system and imaginary compared to today?
- What looks particularly challenging?

The discussions emphasised the interactions and connectedness across systems as well as the differences in conditions, practices and cultures between northern and southern Europe and their impact on sustainability. Table A.1 presents an overview of the system-specific observations collected. The discussions emphasised the perspectives of justice and equality, as well as safety, preparedness and the security of supply. Ongoing Finnish developments, such as rural depopulation and urbanisation and global trade policy were found to have long-term and significant impacts on sustainability. Moreover, considering the cross-system interactions in more detail would have added depth to the examination of the imaginaries.

According to a survey conducted during the workshop, the 'Technocracy for the common good' imaginary was found to represent the most likely future in Finland. Groups focusing on the food and mobility systems stated that Finland is already moving towards *technocracy*. At the same time, the participants agreed that no imaginary alone would be desirable.

Workshop participants were left with a strong desire to amplify facilitated dialogues on the future and on a sustainable Finland, emphasising the importance of the imaginary work conducted by the EEA. Finland is a small country with relatively few hierarchies, so discussion between different parties can be conducted relatively easily. Next time, however, more time would need to be set aside for the workshop to produce more comprehensive and clarified interpretations.

**Table A.1 System-specific observations on the imaginaries from a Finnish perspective**

| | Technocracy for the common good | Unity in adversity | The great decoupling | Ecotopia |
|---|---|---|---|---|
| **Food system** | People in Finland are more willing to try new foods than in southern Europe.<br>Is a return to the old national agricultural policy possible? | Diversification of value chains and production structure is positive, but does EU policy make this possible in Finland?<br>Securing regional/ national food security is an important issue in Finland. | It would be problematic if injustice increased in society due to large companies steering the entire food chain. | Probably part of the solution, but, as such, doesn't seem realistic in Finland. Strengthening community spirit and self-sufficiency would require a change in attitude. |
| **Mobility system** | In cities, this imaginary could come true, but a large part of Finland is outside cities. Technological solutions might therefore be unrealistic. | The implementation of (local) mobility chains in Finland seems challenging in this imaginary. | Is it possible that the organisation of mobility services becomes the responsibility of large multinational companies? | Reducing mobility over long distances in Finland might not be desirable.<br>The spread of the sharing economy is challenging due to low population density and attitudes. |
| **Built environment** | The emphasis on the state in decision-making in the built environment is unrealistic.<br>The culture of leisure housing in Finland is strong. | It is unrealistic to assume that the EU can guide implementation at the local level. | Only the first two imaginaries were examined. | |
| **Energy system** | The conditions underpinning the energy system (electricity, heat and fuel) in Finland are different from other parts of Europe.<br>State-led investments are uncertain in the current economic climate, but does statism create a strong financial sector? | Finland's connection to the European energy system is growing.<br>Finland's EU policy must change. | The totality of energy production is changing.<br>The emphasis on the private sector and the reduction of EU guidance are major changes.<br>Growing socio-economic disparities in society are undesirable. | The energy system is built locally. Where and how do people live (dispersed versus a concentrated urban/ community structure)?<br>Possible conflicts over 'traditional' land use and local energy investments. |

**Source:** Findings from a national workshop took place in Finland in October 2024 to explore and reflect — from a Finish perspective — on the four imaginaries of a sustainable Europe in 2050.

# Annex 2 Guiding questions addressed at the participatory workshops

The following guiding questions were addressed at the online participatory workshops held between 2022 and 2024. Each workshop lasted four hours and followed a format that was tested and adapted following a pilot workshop held with experts from the EEA and the Eionet. Unless explicitly stated, all questions were explored following the logic of the specific imaginary covered by each breakout group.

**Food system workshop** (held on 14 November 2022)

1. A bird's eye perspective of the food system in 2050.
    - What parts of the food system have changed the most? What do they look like?
2. Deep dives into the food system in 2050.
    - What do people eat?
    - How is food produced, who produces it and where?
3. Exploring the realisation of desirable food system outcomes in 2050.
    - How does everyone have access to sufficient, safe, nutritious and healthy food?
    - How does the food system contribute to decarbonisation and environmental health?

**Mobility system workshop** (held on 23 March 2023)

1. A bird's eye perspective of the mobility system in 2050.
    - What parts of the mobility system have changed the most? What do they look like?
2. Deep dives into the mobility system in 2050.
    - Why, how much and how do people move?
    - Why, how much and how do goods move?
3. Exploring the realisation of desirable mobility system outcomes in 2050.
    - How does everyone have access to reliable and safe mobility?
    - How and to what extent is the mobility system decarbonised? What are the trade-offs with other environmental goals?

**Built environment system workshop** (held on 14 June 2023)

1. A bird's eye perspective of the mobility system in 2050.
    - What parts of the built environment have changed the most? What do they look like?
2. Deep dives into the built environment system in 2050.
    - What do buildings look like (from inside and outside)? How are they used?
    - What do human settlements look like?
3. Exploring the realisation of desirable built environment system outcomes in 2050.
    - How does everyone have access to liveable and affordable housing?
    - How and to what extent is the building life-cycle decarbonised? What are the trade-offs with other environmental goals?

**Energy system workshop** (held on 13 September 2023)

1. A bird's eye perspective of the energy system in 2050
    - What parts of the energy system changed the most? What do they look like?
2. Deep dives into the energy system in 2050.
    - What sectors, activities and behaviours drive energy demand?
    - How is the energy demand met? What energy sources, production technologies, energy carriers and infrastructures characterise the landscape?
    - How are (national/EU/other) energy systems planned, optimised and operated?
3. Exploring the realisation of desirable energy system outcomes in 2050.
    - How does everyone have access to affordable and reliable clean energy?
    - How and to what extent is the energy system decarbonised? What are the trade-offs with other environmental goals?

**Cross systems analysis workshop** (held on 24 October 2023)

1. Identifying synergies and tensions between the systems.
    - What synergies and tensions exist between the food, mobility, built environment and energy systems in terms of how:
        - the systems function;
        - a fair, safe and sustainable access to the systems is ensured;
        - decarbonisation is achieved?

2. Strengthening synergies and addressing tensions.
    - How can the synergies identified be strengthened?
    - How can the tensions identified be addressed?
    - What actions and actors can help to realise these synergies and address the tensions?
3. Commonalities in synergies and tensions across the imaginaries.
    - What synergies and tensions are common across imaginaries?

**Future disruptions workshop** (held on 16 April 2024)

1. Inception of the imaginary.
    - What are the critical dependencies that make the imaginary viable?
    - Who are the key actors that compose the imaginary's societal fabric?
2. Vulnerability to future disruptions in 2050.
    - How do major (single and co-occurring) future disruptions unfold their impact in 2050?
    - How vulnerable is Europe to these (single and co-occurring) future disruptions in 2050?
3. Resilience to future disruptions in 2050.
    - Which capacities can Europe build upon to respond to these (single and co-occurring) future disruptions in 2050?
    - What critical capacities need to be developed in addition to successfully deal with major (single and co-occurring) future disruptions in 2050?

# Annex 3 The set of future disruptions considered

A literature review, including previous work conducted by the European Topic Centre for Sustainability Transitions (ETC ST), was carried out to identify and characterise suitable future disruptions that could challenge the storylines of the imaginaries. An initial set of future disruptions covering the STEEP domains was compiled and consolidated (see Table A.3) and each disruption was described. These 26 future disruptions were pre-assessed in how far they questioned the key dependencies of the imaginaries; this was done to pre-select three disruptions per imaginary for consideration at the future disruptions workshop, held on 16 April 2024.

**Table A.3 List of future disruptions considered**

| STEEP domain | Short title |
|---|---|
| **Social** | Massive brain drains. |
| | Culture clashes. |
| | Paralysis of the public sphere. |
| | Incommensurability of opinion. |
| | Explosive social disparities. |
| | The progress narrative ends. |
| **Technological** | Massive breakdown of digital systems. |
| | Carbon capture breakthrough. |
| | Green tech failure. |
| | Opaque technology out of control. |
| **Economic** | Financial crisis 5.0. |
| | Massive divestment. |
| | Collapse of essential systems of provision. |
| | The world is for sale. |
| **Environment (and health)** | Climate disasters. |
| | Ecosystem collapse. |
| | Famines. |
| | Mental health crises. |
| | Public health crises. |
| | Uninhabitability of large areas. |
| **Political** | Absence of peace. |
| | Bureaucratic sclerosis. |
| | Collapse of trust in governance. |
| | Global cooperation fails. |
| | Democracy crisis. |
| | Earth control in the digital age. |
| | Radical geometry changes of international organisations. |

**Sources:** EEA's compilation based on OECD, 2025; WEF, 2023, 2024; EPRS, 2023.

## Descriptions of the future disruptions considered

### *Disruption: massive breakdown of digital systems in Europe*

In 2050, digital systems break down frequently and entangle other systems such as energy. The internet of everything — the network of connections between people, things, processes, and data — is so complex, opaque and inaccessible that the causes of the breakdowns remain mostly unknown. Cyberattacks are regularly carried out by numerous and capable state and non-state actors. Another cause is the dysfunctionality of digital systems, either through unmastered complexity or through deliberate action. Digital system oligopoly has poor incentives to make digital systems robust. Companies earn their fortunes by gaining as many clients as possible, for free or at very low cost. This makes clients dependent, while firms monetarise waiting time and dysfunctionality by selling expensive premium products. Digital connectivity soars globally.

### *Disruption: absence of peace worldwide*

In 2050, we live in an age of non-peace. Several dormant regional conflicts are active, including the claims of China on Taiwan, Russia's attempts to restore the Soviet empire and India's conflicts with Pakistan and China. In addition, the race for global dominance brought the world to the edge of a global war. In a highly interconnected world, the distinction between war and peace is blurred, as troops are partially replaced by sanctions, cyberwar, the manipulation of opinion or of border controls, terrorist attacks, systematic unnoticed espionage and the instrumentalisation of migration against enemy countries. Even if there is no current war, spending on security and military — on new AI-steered weapons, for example — is very high. This leaves less room for manoeuvre for other expenditures.

### *Disruption: paralysis of Europe's public sphere*

In 2050, communication occurs in disrupted public spheres only, subject to hidden commercial interests. It is characterised by deception and manipulation, persuasive misinformation and disinformation campaigns as well as echo chamber effects. People live in post-privacy virtual worlds where privacy has been lost; they hardly communicate face to face ,blending private life with digital publics formed around shared interests, issues, and identities. Despite digital connectivity, the feeling of loneliness and superficiality is widespread. Digitalisation, with its deep fakes, cyber insecurity and hidden interests, has had massive impacts on communication, the media landscape and social cohesion. Network segregation means that people prefer to remain among themselves. This phenomenon has trapped most societal groups, ranging from right-wing populists to green communities.

### *Disruption: uninhabitability of large areas worldwide*

In 2050, a significant portion of the Earth's land surface is uninhabitable. This means that many people have been forced to leave their homes; this is especially the case across Africa, south and southeast Asia and Latin America. Some island states have ceased to exist. Climate change with its unbearable heat, forest fires, flooding and sea level rise has been a major driver for uninhabitability. Due to heat, outdoor work, manual labour and recreational activities are impossible during daylight hours for several months a year in many countries. Depreciation of soil fertility drives rural population to the cities. Entire cities are relocated and floating cities carry a significant share of the population. Several wars in Eurasia and Africa have devastated and contaminated large areas. These will need decades and immense investment to be restored, long after 2050.

***Disruption: collapse of trust in EU governance***

In 2050, trust in EU governance is diminishing substantially. The complexity of problems faced in the age of polycrisis greatly overburdens governance capacities and deceives transparency expectations of the population. The capabilities of governments to meet their citizens' expectations and the reliability of governments to consistently and dependably deliver high quality governmental and public services are not up to the task of dealing with the entangled crises. In addition, socio-economic polarisation as well as angst and despair undermine trust in governance, democratic participation and support for the carefully designed and coordinated transformation programmes.

***Disruption: global financial crisis 5.0***

In 2050, financial systems are in persistent crises. Several countries with strong economies face an unexpected drop in international capital inflows, accompanied by speculative attack on their currencies; this results in sharp depreciation. The countries are not able to service their foreign debts or meet their domestic fiscal obligations. Countries get stuck in 'stagflation', while public services collapse, leading to social distress. In large world regions, debts grew incrementally when governments needed vast amounts of money to finance transformations, react to disasters and stabilise banks too big to fail. Instability of the financial system skyrocketed when the Fintech sector developed ever more complex and risky financial products, derivates and cryptocurrencies, engaging in ultra-fast trading.

***Disruption: public health crisis worldwide***

In 2050, incidents, accidents, contaminations, pollution and infections dominate the public discourse. Morbidity and mortality levels are high in some world regions and even globally in times of repeated pandemics. Zoonotic disease outbreaks are common due to higher human and animal population densities and closer contact, following human settlements encroaching further into former wildlife and the emerging middle classes interacting with livestock in markets. Proliferation of biotechnology has driven accidental or malicious leaks of synthetic pathogens. The increase in transmission is driven by global travel and trade, climate change and altered ecosystem-coupling as well as the development of antimicrobial resistance.

***Disruption: climate disasters in Europe***

In 2050, the Earth's system reorganises in abrupt and irreversible ways. Irreversible cascading tipping points include the sea level rise from collapsing ice sheets, carbon release from thawing permafrost and the disruption of ocean and atmospheric currents. Extreme weather events bring unbearable heat, prolonged droughts, water scarcity and fires, as well as torrential storms, precipitation and large-scale flooding; some regions become colder, others are prone to desertification. Dangerous warming was inevitable, regardless of action to reduce GHG emissions. The global focus shifted from avoiding climate change to bracing for — and adapting to — a near worst-case scenario over the coming decades.

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