

# Quantification of the Environmental Benefits of Circular Economy Actions



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## 2 Summary / Description

This task builds upon the report (Vercauteren et al., 2025) which examined the potential impact of doubling the circular material use rate (CMUR) by 2030. A key takeaway from that study was the need for more refined assumptions and a structured methodological approach to effectively quantify environmental benefits.

The current report focuses on defining the circular economy (CE) scope, selecting key CE measures, and quantifying their impacts on the economic structure of Europe and subsequently on the material flows and environmental impacts. One of the main challenges is the variation in CE definitions across studies from organizations such as e.g. the Ellen MacArthur Foundation, Circle Economy Foundation, and Material Economics. Some interpretations include dietary shifts, regenerative agriculture, or energy efficiency, while others do not. This study provides an overview of CE interventions modelled in the literature, and analyses the CE scope these belong to. Additionally, underlying assumptions in CE models significantly influence results. This study reviews existing assumptions, assesses their feasibility, and develops an approach for quantifying CE measures' effects on material flows. Ultimately, this study aims to enhance the robustness of CE impact modelling in order to inform future policy and research.

Based on a review of the scientific literature, the report first defines which CE interventions fall inside its analytical boundary, distinguishing core measures that directly slow or close material loops (e.g. reuse, repair, remanufacturing, high-quality recycling) from broader measures that mainly narrow resource flows or serve other policy goals such as climate or energy efficiency. It then classifies interventions via the mechanisms “close, slow, narrow” and checks how they are framed in EU policy (CE policy vs. other domains) to decide whether they are treated as core CE, broader CE, or outside scope. Grey-zone measures are handled through explicit, normative boundary choices, informed by expert judgement and lifecycle considerations. Finally, all included interventions are organised along the product life cycle (before-use, during-use, after-use) to support consistent scenario design and impact modelling.

The modelling results (Figure 2-1) illustrate that the **implementation of the selection of core and broad CE interventions** (high ambition level, current economy) leads to a reduction of 22% for climate change, 25% for particulate matter and 19% for land-use based biodiversity loss. As environmental impacts caused by EU-27 consumption occur in Europe and abroad, a significant share of the benefits of CE interventions also occurs outside the EU-27. Between one-third and nearly half of the reductions in climate change, air pollution and biodiversity impacts take place outside EU borders, underlining the importance of a consumption-based footprint perspective for assessing CE policies. However, it is important to note that – due to methodological limitations and uncertainties – the results of this study are best understood as order-of-magnitude estimates that support comparison between interventions and help identify priority areas for policy and impact assessment.

Distinguishing between **core and broad CE interventions** shows that core CE interventions are essential to reduce environmental impacts, however, they should be complemented by CE interventions with a broader scope to reach a significant reduction. The four broad-group interventions have substantial reduction potential across all three environmental impact categories, coming close to the reduction delivered by the 13 interventions in the core group. This is because the broad CE scope includes far

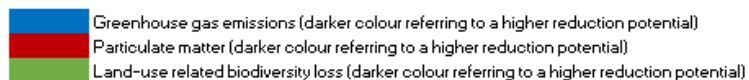
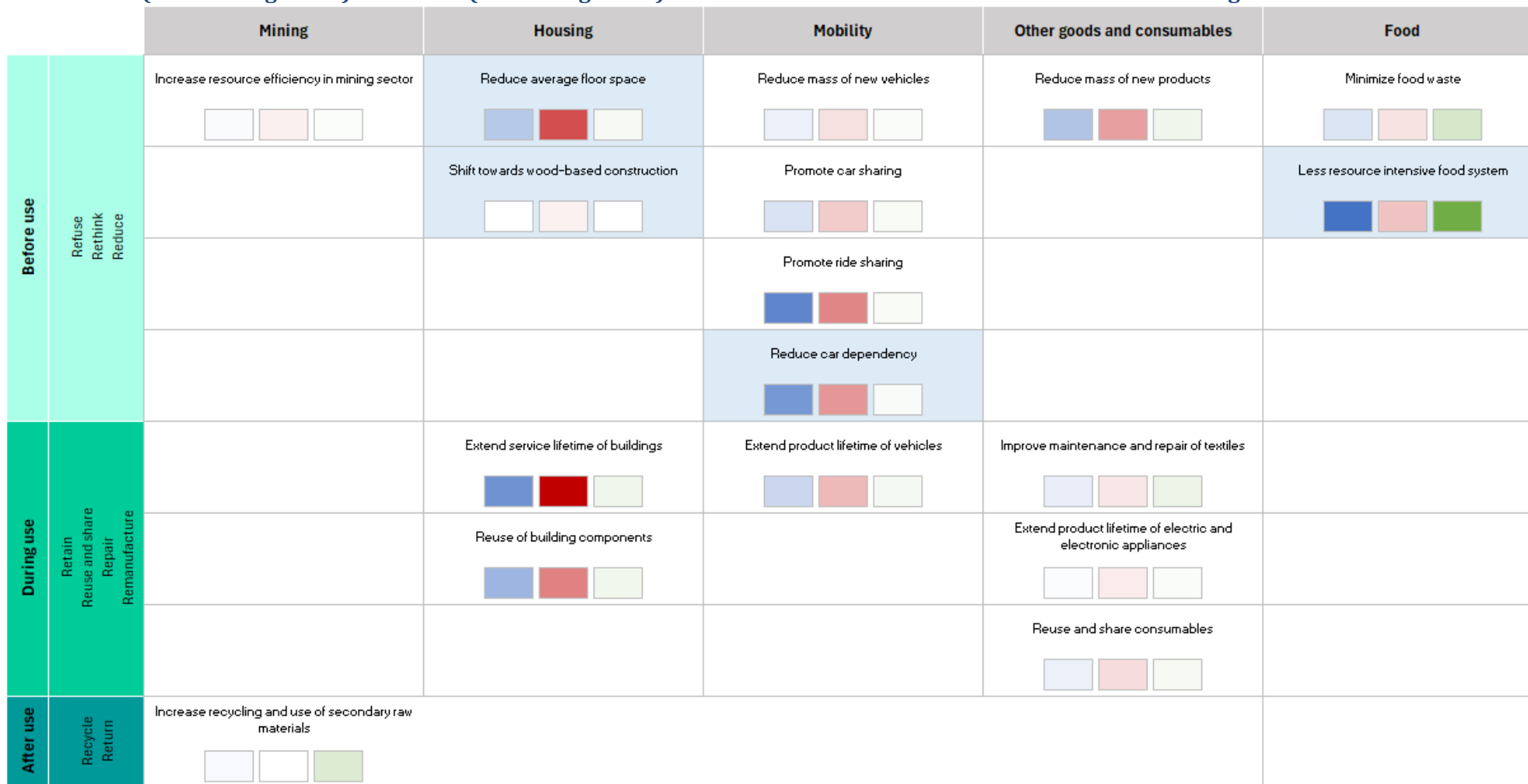
reaching interventions like introducing a less resource intensive food system (dietary shift), reducing average floor space in houses and reducing car dependency (modal shift). Interventions that directly slow and close material loops (e.g. reuse, repair, lifetime extension, high-quality recycling) account for a substantial share of impact reductions, while broader measures — including demand-side changes and material substitution — provide important additional benefits, particularly for biodiversity.

The choice of **ambition levels** for CE policy interventions relates directly to the potential of these interventions to generate environmental benefits, indicating that incremental changes are unlikely to realise the full environmental benefits of the circular economy. At this stage, our modelling does not cover the socio-economic impacts of the CE interventions, which would be necessary to determine the socially optimal ambition levels of these interventions. However, our results clearly illustrate that the potential environmental benefits of CE interventions in the current economic structure are significant (10-14% reduction of global environmental impacts at medium ambition levels, increasing to 19-25% at high ambition levels).

**CE interventions** acting before and during product use deliver the largest impact reductions. Measures such as reducing demand for new products, extending product and component lifetimes, sharing systems, and improving product design consistently show higher environmental benefits than end-of-life measures alone.

This study illustrates the need for policy makers to carefully evaluate which CE strategies yield the greatest environmental benefits and how different types of measures interact across sectors and provisioning systems. Applying a consistent modelling framework across interventions and scopes can help to identify high-impact options. Transparent scoping, defining core versus broad measures upfront, is essential to ensure robust and comparable results.

**Figure 2-1: Overview of reductions in the climate change (blue), particulate matter (red), and biodiversity (green) footprints of EU-27 consumption. Shows individual core (white background) and broad (blue background) CE interventions in the 2020 economic structure at high ambition level.**



Source: ETC-CE own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity (land-use related biodiversity loss (10<sup>-3</sup>) global pdf). A colour scale is used to indicate the relative reduction potential, with a darker colour referring to a higher reduction potential. The light-blue shaded interventions refer to the broad CE interventions. The modelling of the individual core and broad CE interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (based on the high ambition level). The reduction potential is equal to the difference between the current EU-27 consumption footprint and a what-if scenario in which the circular economy interventions are implemented using the high ambition level. The footprint includes global environmental burdens, such as e.g. GHG and particulate matter emissions and land use, linked to annual final demand in the EU27 (including scope 1, 2 and 3).

### 3 Introduction and policy background

Existing modelling studies on the environmental benefits of the circular economy (CE) report widely differing results with regard to the magnitude and distribution of impact reductions (Günther et al., 2026). These differences arise not only from variations in modelling techniques, but also and perhaps more importantly from differences in the scope of interventions, targets and assumptions underlying each study. For example, the recent ETC/CE report 2025/3 developed a methodological framework using the Circular Material Use Rate (CMUR) and assessed potential reductions in climate change, air pollution and biodiversity loss with scenarios to double the CMUR in line with the EU Circular Economy Action Plan (Vercauteren et al., 2025). In contrast, other studies may focus on specific sectors, material flows, or broader socio-economic pathways, leading to results that are not directly comparable even when expressed in similar indicators.

Recognising these vastly differing scopes is essential for interpreting modelling results correctly and understanding what type of policy questions a given modelling exercise can realistically inform. When interpreted transparently and in relation to their underlying assumptions, CE modelling results can help identify priority intervention areas, highlight trade-offs and synergies across environmental objectives, and support the design and ex-ante assessment of policy packages. They can provide valuable input for policymakers and impact assessments by indicating where environmental potential is greatest — whether in material reuse, recycling, product life extension, or system-level shifts — and by clarifying how outcomes relate to defined targets and scenarios.

In this report, we build on earlier work within the same project by systematically reviewing how CE interventions are defined, scoped, and quantified in existing modelling studies, and by translating this diversity into a transparent and policy-relevant analytical framework. The report maps a wide range of CE interventions discussed in the literature, distinguishes between core and broader CE strategies, and assesses their suitability for quantitative modelling. Selected interventions are then implemented in an environmentally extended input–output (EEIO) framework to estimate their potential effects on the economic structure and subsequently on material flows and associated environmental impacts from a consumption-footprint perspective. By applying a consistent modelling approach across interventions and scenarios, the report provides a structured comparison of results and highlights how differences in scope, ambition and system context influence estimated outcomes, thereby supporting interpretation and use of CE modelling results in policy analysis and impact assessments.

## 4 Goal and scope of this report

The primary objective of this task is to advance the understanding and measurement of the environmental (and socio-economic benefits) of a circular economy (CE). Building on insights from the AP2024 task “*Measuring Environmental Benefits of Circular Economy*” (Vercalsteren et al., 2025), which examined the potential environmental benefits of doubling the circular material use rate (CMUR) by 2030, this work seeks to address key methodological gaps and strengthen the robustness of modelling approaches. Specifically, this report focuses on selecting a range of CE interventions that relate to different CE scopes and action fields (e.g., mobility, housing, industry, food and agriculture, etc.), and that can be modelled using Environmentally Extended Input Output (EEIO) analysis building on our 2024 work.

This report adopts a **footprint-based approach** rather than focusing solely on territorial impacts. The footprint measures global environmental pressures that can be linked to EU-27 consumption. Part of this footprint consists of impacts occurring within EU territory, but it also includes impacts generated elsewhere in the world through production and trade activities that supply European societal consumption. However, the overlap is incomplete because some territorial impacts in the EU arise from production for non-EU export markets, which belong to other countries' consumption footprints rather than the EU-27 footprint.” (EEIO footprints exclude EU exports while including imports).

The **first part** of the report concentrates on defining the scope of CE for selecting which CE interventions to model. Key activities include investigating various definitions and scopes of CE, screening the literature for CE interventions that have been modelled in the science and policy literature, analysing their implications for impact modelling, and engaging with experts to ensure a final policy-relevant selection of CE actions to be modelled. The **second part** of the report uses this selection of CE interventions to implement these into the Multi-Regional Input-Output (MRIO) modelling framework developed during this task, develop different scenario narratives, and carry out model runs to more holistically assess the environmental impacts savings of the CE in Europe.

## 5 Circular economy (CE) scope and interventions

### 5.1 CE definitions

The Circular Economy (CE) concept has no single origin, but key contributors include John Lyle, William McDonough, Michael Braungart, and Walter Stahel (Winans et al., 2017). Influences range from Rachel Carson’s *Silent Spring* to the Club of Rome’s limits to growth and work by eco-economists like Herman Daly (Winans et al., 2017). The CE builds on frameworks like the 3Rs (reduce, reuse, recycle), 6Rs, and the 9Rs used e.g. by the EEA (EEA, 2024), and intersects with related ideas that predate it such as industrial ecology, resource efficiency, industrial symbiosis, and eco-cities (Winans et al., 2017). In Europe, the concept has been promoted by the European Commission (EC) since the first CE Action Plan in 2015<sup>1</sup> and the subsequent adoption of the 2020 CE Action plan. The Commission will adopt a new Circular Economy Act in 2026<sup>2</sup>.

The **EU Action Plan for a Circular Economy, COM (2015) 614<sup>3</sup> final** defines the CE as follows:

*“A more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is an essential contribution to the EU’s efforts to develop a sustainable, low carbon, resource efficient and competitive economy.”*

However, various other CE definitions exist depending on the country or region, institution, and policy context. The UNECE Guidelines for Measuring Circular Economy (UNECE, 2023) highlight a number of additional and prominent CE definitions used in the policy context, some of which are highlighted in Table 5-1 below (see the UNECE document including its annex for details).

**Table 5-1 Overview of selected circular economy (CE) definitions summarized in the UNECE Guidelines for Measuring Circular Economy (UNECE, 2023)**

<b>OECD working definition:</b> <i>“A circular economy is an economy that seeks to (1) Maximise the value of the materials in the economy, (2) Minimise material consumption, in particular virgin materials, hazardous substances, (3) Prevent waste from being generated and reduce hazardous components in waste and products. Sustainable Materials Management ISMM) is defined as “...an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity.””</i>
<b>Bellagio declaration, Circular economy monitoring principles (EEA; EPA Network; ISPRA; SNPA), final (Dec. 2020)</b> <i>“A circular economy is an economy where the value of products, materials and resources is maintained in the economy for as long as possible. All outputs from one process is input for another. Thus, a move towards a circular economy entails reducing the intake of virgin materials and reducing the generation of waste.”</i>
<b>UNECE-TF WP2 - Jan. 2022</b> <i>“A circular economy aims to minimize globally the input of natural resources and the generation of residuals by maintaining the value of goods and materials for as long as possible and by returning materials into the product cycle at the end of their use.”</i>
<b>UNEA 5 declaration (UNEP/EA.5/Res.11)</b> <i>“Recalling its resolution 4/1 on innovative pathways to achieve sustainable consumption and production, which acknowledged that, along with other sustainable production and consumption approaches, a more circular economy, in which products and materials are designed in such a way that they can be reused, remanufactured, recycled or recovered and thus maintained in the economy for as long as possible, along</i>

<sup>1</sup> [https://environment.ec.europa.eu/topics/circular-economy/first-circular-economy-action-plan\\_en](https://environment.ec.europa.eu/topics/circular-economy/first-circular-economy-action-plan_en)

<sup>2</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0085>

<sup>3</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52015DC0614>

<p><i>with the resources of which they are made, and the generation of waste, especially hazardous waste, is avoided or minimized, and greenhouse gas emissions are prevented or reduced, can contribute significantly to sustainable consumption and production.”</i></p>
<p><b>Ellen MacArthur Foundation (website glossary; accessed Oct. 2020)</b></p> <p><i>“The circular economy [is] a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature. It is underpinned by a transition to renewable energy and materials. Transitioning to a circular economy entails decoupling economic activity from the consumption of finite resources. This represents a systemic shift that builds longterm resilience, generates business and economic opportunities, and provides environmental and societal benefits.”</i></p>
<p><b>EU Taxonomy Regulation, Regulation 852 (2020)</b></p> <p><i>“Circular economy means an economic system whereby the value of products, materials and other resources in the economy is maintained for as long as possible, enhancing their efficient use in production and consumption, thereby reducing the environmental impact of their use, minimising waste and the release of hazardous substances at all stages of their life cycle, including through the application of the waste hierarchy.”</i></p>
<p><b>International Organization for Standards (ISO):</b></p> <p><i>“[The circular economy is an] economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development.”</i></p> <p><i>Note 1 to entry: Resources can be considered concerning both stocks and flows.</i></p> <p><i>Note 2 to entry: The inflow of virgin resources is kept as low as possible, and the circular flow of resources is kept as closed as possible to minimize waste, losses and releases from the economic system.</i></p>
<p><b>UNECE-TF WP2 - Jan. 2022</b></p> <p><i>“A circular economy aims to minimize globally the input of natural resources and the generation of residuals by maintaining the value of goods and materials for as long as possible and by returning materials into the product cycle at the end of their use.”</i></p>

In the scientific literature, (Kirchherr et al., 2023) analysed 221 recent CE definitions and coded them regarding CE core principles (building on their 2017 work (Kirchherr et al., 2017)). The majority of studies relate to the core principles:

- Recycle (“Discussion around, e.g., recycling, closing the loop, cycling and/or reuse of waste. Explicit reference to any x-R framework that includes “recycle”),
- Reuse (Discussion around, e.g., reusing, repairing and/or refurbishing of products/resources. Explicit reference to any x-R framework that includes “reuse”)
- Reduce (Discussion around refusing, rethinking, redesigning (including prolonging the lifespan of products), minimization, digitization and so reduction and/or prevention of resource use and preserving of natural capital. Explicit reference to any x-R framework that includes “reduce”) (Kirchherr et al., 2023).

(Kirchherr et al., 2017)) conclude with a proposed CE-definition:

*“A circular economy describes an economic system that is based on business models which replace the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso-level (eco-industrial parks) and macro level (city, region, nation, and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.”*

From this summary of some of the key CE definitions, it becomes evident that there is no universally accepted CE-definition or terminology. Its meaning varies across countries and academic literature, depending on the objectives pursued and the policies implemented. **Most definitions share the principle of circularity and the goal of transitioning from traditional linear business models to more circular ones.**

A *core perspective* defines a CE in relation to the linear economic system, focusing on closing resource loops within existing value chains as well as emphasizing slowing material flows, either through increased circularity within an economy or by extending product lifespans in a predominantly linear system. The *broader perspective* considers CE as a strategy for more efficient and sustainable use of natural resources, materials, and products, including reducing consumption (e.g., prioritizing services over products) and sometimes also including the regeneration of nature.

## 5.2 Classification of CE interventions according to different CE-scopes

### 5.2.1 CE intervention types in the scientific literature

#### *Core CE strategies*

**Close and slow.** Moraga and colleagues (Moraga et al., 2019) adapt the rationale of Bocken and colleagues (Bocken et al., 2016) to define CE with a limited focus as having two characteristics from the linear economy, namely *slowing and closing resource loops*.

Slowing occurs by designing long-lasting goods and extending product lifespans through service loops, such as repair and remanufacturing. This approach lengthens and/or intensifies the utilization period of products, thereby decelerating the flow of resources.

Closing, on the other hand, involves creating a closed loop between post-use and production, enabling a circular flow of resources. This process transforms linear waste flows into secondary resources.

In other words, CE interventions or strategies with a core (limited) focus often relate to:

- (1) Closing supply chains (the return of materials to various stages of the supply chain after use, such as through end-of-life recycling),
- (2) Product life-time extensions (linked to reducing resource consumption by extending the lifespan of products, such as through durable design and enhanced maintenance, reuse, refurbishment, remanufacture)

**Narrow.** Narrowing loops reduces resource use in production without directly affecting product flow speed or involving service loops like repair. However, resource efficiency (successfully applied even in linear models) can complement core CE strategies like product life extension and high-quality recycling (Bocken et al., 2016).

Examples include materials efficiency improvements (fewer inputs per unit of output), scrap diversion (e.g., less swarf from metal cutting), and yield loss reductions during processing.

While (Bocken et al., 2016) exclude narrowing from a limited CE definition due to its lack of cycling, this report includes select narrowing interventions as core enablers because they directly support circular material loops (e.g., by increasing recycling feedstock quality/quantity or reducing virgin material needs alongside loop closure). This ensures the modelling captures realistic CE transition pathways where efficiency gains amplify circularity impacts.

#### *Broader CE strategies*

However, several “CE boundary interventions” related to resource efficiency (narrowing) are already embedded in other policy domains and typically not viewed by EU institutions as core CE strategies. For example, improved building insulation can be classified as a process improvement intervention that reduces the demand for energy carriers while increasing the demand for insulation materials, without necessarily enhancing material circularity. At the same time, such interventions are primarily framed under EU energy efficiency policy and may therefore not be recognised as key CE actions. By contrast, wood-based construction represents a design-oriented resource efficiency intervention and is more likely to be

treated as a CE activity in a broad framing, given its emphasis on material substitution and altered building designs.

A broader conceptualization of the CE is discussed in the literature, for example by (Moraga et al., 2019), building on (Murray et al., 2017), who define the CE as *"an economic model wherein planning, resourcing, procurement, production, and reprocessing are designed and managed, both as processes and outputs, to maximize ecosystem functioning and human well-being"*. This definition emphasizes sustainability and the impact of CE strategies on the economy, environment, and society.

The Ellen Mac Arthur Foundation, for instance, views the CE as *"a system where material never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources."* (see Ellen Mac Arthur Foundation webpage<sup>4</sup>). This understanding explicitly covers both finite materials and renewable resources. **"Regenerate"**<sup>5</sup> in the circular economy context refers to shifting from the depletion of natural resources to their restoration by adopting farming and production practices that rebuild soils, enhance biodiversity, and return biological materials safely to the biosphere. This approach mimics natural cycles, in which waste is eliminated and resources are continuously regenerated.

**Certain demand-side strategies** such as car sharing, intensified building use, or dietary shifts offer substantial material savings and associated environmental impacts reduction (Creutzig et al., 2024), but are often framed under climate or mobility policies and require consumption behaviour changes. For example, the adoption of sharing concepts for cars and other modes of transportation can lead to significant resource savings. Whether such interventions are considered part of core or broad CE strategies therefore depends on the specific policy context and framing.

The interventions discussed here can be clustered into three groups:

- (1) Interventions that reduce resource use mainly as a co-benefit while pursuing other primary objectives (e.g. climate mitigation or biodiversity conservation), such as phasing out fossil fuels or implementing energy efficiency measures;
- (2) Regenerative agriculture and forestry as a particular case of regenerative practices; and
- (3) Interventions targeting behavioural and consumption changes. The latter are frequently omitted from CE policy discussions due to (perceived) lack of social and political acceptability.

In conclusion, many CE interventions, in particular those associated with "narrow" CE strategies, require normative choices regarding their inclusion or prioritization, which are contingent on the specific policy background and objectives.

### 5.2.2 Expert views and science-policy interface

While the above science-based classification of CE interventions into a range of "broad" and "narrow" types can be helpful, the discussion also shows that there is a considerable "grey zone" of CE measures that cannot be clearly associated with only one or another CE strategy.

Against this background, an online expert workshop was held in June 2025 with participants from European and national environmental agencies, international organisations, research institutes, and civil society organisations working on circular economy and sustainability to discuss their views on core vs. broad CE interventions.

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<sup>4</sup> <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview> (accessed on March 21, 2025).

<sup>5</sup> <https://www.ellenmacarthurfoundation.org/regenerate-nature>

Experts broadly agreed that “core” CE interventions are those that directly slow and close material loops, for example through product lifetime extension, high-quality recycling, reuse, and remanufacturing, and that clearly improve circularity indicators such as CMUR or the material footprint. By contrast, strategies that primarily target other objectives (e.g. climate mitigation, energy efficiency, or general resource conservation) but have resource or circularity co-benefits were typically judged as “peripheral” or outside CE, even when they contribute to narrowing resource flows.

Participants highlighted a substantial grey zone of “boundary” interventions, including energy system decarbonisation, building insulation, regenerative agriculture, electrification, climate taxes, and remote work, where views diverged on whether these should count as core, peripheral, or non-CE measures. In these cases, experts emphasised that classification depends on the main purpose (e.g. climate vs CE), environmental effectiveness, life-cycle perspective, and whether the measure alters product/material cycles rather than only reducing upstream inputs.

Several experts argued for a broader CE framing in which circular economy and resource conservation are treated as a single package, allowing inclusion of substitution (e.g. bio-based materials), regenerative agriculture, and some demand-side measures, provided they demonstrably reduce overall environmental impacts. At the same time, it was stressed that excluding an intervention from “core CE” does not imply that it is “linear”; rather, it may simply fall into another policy domain, underscoring that the core–broad distinction is a normative, context-dependent science–policy choice.

### 5.3 Approach used to classify CE interventions into core and broad

A wide range of studies has examined the environmental impact savings associated with circular economy (CE) interventions. To capture measures spanning both core and broad CE scopes, the analysis focused on the following publicly available reports:

- Circularity Gap Report (Circle Economy, 2023)
- Donati et al. (Donati et al., 2020a)
- Capturing the Potential of the Circular Economy Transition in Energy-Intensive Industries, JRC (Walker et al., 2025)

In addition, numerous other studies examine CE interventions and their environmental benefits (e.g., (Rommens et al., 2024; WWF, 2023; Wiedenhofer et al., 2025; Günther et al., 2026)). However, the selected reports were considered sufficient for scenario construction (section 6), as they already cover a broad spectrum of CE measures relevant to the EU policy context.

A three-step procedure was then applied to classify the policy interventions identified in the literature into core and broad CE scopes.

- **Step 1: CE Mechanism (slow, close, narrow)**

Each of the CE interventions derived from the literature was classified according to its CE strategy and intervention using the framework by (Aguilar-Hernandez et al., 2018; Donati et al., 2020a) (Table 5-2).

**Table 5-2 Circular economy (CE) strategies and interventions (based on (Aguilar-Hernandez et al., 2018))**

Strategy	Description	Intervention	Operationalization in scenarios	CE Scope
Closing supply chains (CSC)	The return of materials to various stages of the supply chain after use, such as through product reuse, component reuse, refurbishment, or recycling.	Reuse, Redistribution, Refurbishment, Remanufacture, Recycle	Increasing closed loop activities by changing input-output flows. End-of-Life (EoL) activities use waste outputs as inputs to produce usable products (Aguilar-Hernandez et al., 2018).	Core
(RWM) Residual waste management <sup>6</sup>	Referring to post-consumption processes where materials are removed from the economy, such as through landfill disposal.	Landfill, energy recovery, other waste treatment	Introducing new waste treatment activities with improved technology (e.g., lower emissions or more efficient processing). Adjustments in the inputs from the rest of the economy. Necessary to introduce a capacity constraint of how much waste can be processed (Aguilar-Hernandez et al., 2018).	Core
Product Lifetime Extension (PLE)	Linked to reducing primary resource consumption by extending the lifespan of products, such as through durable design and enhanced maintenance.	Reuse and remanufacturing (Donati et al., 2020a)	Reduce transaction of new products or components and increase services (e.g., maintenance and repairing services).	Core
		Delayed product replacement (Donati et al., 2020a)	Reduce transactions of new products or components and increase services. Increases in material demands for better product durability might be required.	Core
Material Resource Efficiency (RE)	Methods or systems that enhance resource efficiency by reducing the amounts of resources used per unit of production.	Scrap diversion (Donati et al., 2020a)	Reduction of swarf due to mechanical processing such as metal cutting. Reduction of scrap to recycling activities and reduction of the equivalent amounts of primary materials.	Core
		Yield loss reduction (Donati et al., 2020a)	Reduction of physical losses during processing. Model implementation similar to scrap diversion (but including possible material substitutions).	Core
		Process improvements (Donati et al., 2020a) and substitution	Adjustments in environmental extensions (emissions levels), Reduction in material requirements or shifts in material needs (substitution).	Core or broad (depending on specific measure)
		Design improvements (Donati et al., 2020a)	Reduced material demands for manufacturing activities.	Core or broad (depending on specific measure)
		Use intensification (Donati et al., 2020a)	Using products more over a time-period results in lower demand for new goods, but possibly higher demand for components and maintenance services.	Core or broad (depending on specific measure)
		Sharing (Donati et al., 2020a)	Product use among multiple users reduced the demand for virgin products, while the need for services increases.	Core or broad (depending on specific measure)

<sup>6</sup> Note that waste management refers to “traditional” waste policy and not wider circular economy policy according to the EU definition. However, it was included in the table as it was originally included by the authors (Aguilar-Hernandez et al., 2018) in their overview of CE strategies and interventions.

Interventions whose main mechanism is slowing and/or closing product and material loops are classified as “core CE,” consistent with the limited CE focus in Moraga/Bocken (section 5.2.1). Interventions that primarily narrow flows, change input mixes, or reduce demand (without necessarily organising circular use of specific products/materials) are candidates for “broad CE” or outside CE, depending on Steps 2 and 3.

Note that the classification of CE interventions into the intervention types reported in Table 5-2 was explicitly designed to align them with the modelling framework used to quantify their environmental impacts, namely environmentally extended input–output (EEIO) analysis (see Section 6 on the modelling framework).

- **Step 2: Primary policy purpose and framing**

During this step, the EU policy landscape was screened to assess whether the interventions identified in the literature are already covered by existing EU policy fields. This addresses the challenge that, although these interventions may relate to CE strategies (closing, slowing, and narrowing) and the corresponding intervention types (Table 5-2), they may already constitute central elements of other EU policies and therefore be perceived by policymakers as lying outside the immediate scope of EU CE policy.

- **Step 3: Expert review and normative CE boundary setting**

A final review of all CE interventions was carried out jointly by the ETC CE and the EEA and during a workshop with external experts, applying a normative boundary decision that combined the strategy–intervention typology (Step 1) with the primary policy framing in the EU (Step 2).

Interventions whose dominant mechanism clearly slows or closes product and material loops and that are explicitly framed as circular economy measures in EU policy were confirmed as core CE; examples include “Minimizing food waste,” classified under resource-efficiency/yield-loss reduction and embedded in the Farm to Fork Strategy and the EU Platform on Food Losses and Food Waste, and “Circular construction,” which increases recycled content in construction materials under the Circular Economy Action Plan (Table 5-3).

Similarly, reuse and lifetime extension measures such as increased reuse of steel and aluminium components in buildings, higher recycled content and reuse in vehicles, and extended lifetimes of electrical appliances were treated as core CE because they directly organise reuse, repair, and recycling loops and are anchored in CE-oriented instruments such as the Ecodesign for Sustainable Products Regulation, the Sustainable and Circular Textiles Strategy, and the proposal on circularity requirements for vehicles (Table 5-3).

By contrast, several interventions that fit material resource-efficiency categories in the typology were not classified as core CE when their primary policy framing and logic lay elsewhere. For instance, “Promoting balanced nutrition / reducing meat consumption” was assigned to broad CE: although it reduces biomass footprints through dietary change, it is mainly driven by health and nutrition policies (e.g. labelling schemes) and was viewed by experts as substitution- or efficiency-oriented rather than loop-closing (Table 5-3).

Likewise, “Reducing floor space” in housing and “Wood-based construction” were classified as broad CE, because they primarily act via demand reduction or material substitution and are discussed across housing, climate, and construction policy fields rather than as explicit circularity measures, despite their strong relevance for material use and long-term stocks (Table 5-3).

**Table 5-3 Aggregate overview of selected CE interventions and their classification (illustrative, non-exhaustive)**

<b>Intervention (short label)</b>	<b>Domain / main strategy</b>	<b>Final classification</b>	<b>Short reasoning</b>
Minimizing food waste	Food; yield loss reduction / resource efficiency	Core CE	Reduces avoidable food losses and is embedded in EU initiatives on food waste prevention.
Promoting balanced nutrition / reduced meat consumption	Food; dietary shift / substitution	Broad CE	Demand-side dietary change with strong environmental benefits, but mainly framed via health and climate policy.
Extend service lifetime of buildings	Housing; product lifetime extension	Core CE	Slows material loops by extending building lifetimes via repair, maintenance, and circular design.
Reuse of building components	Housing; reuse / closing supply chains	Core CE	Organises component reuse and higher recycled content in construction; explicitly framed as CE.
Reducing average floor space	Housing; use intensification / demand reduction	Broad CE	Limits stock expansion and material demand, but acts primarily via service-demand reduction.
Wood-based construction	Housing; material substitution / design	Broad CE	Substitutes carbon- and material-intensive materials with wood; mainly a substitution and regenerative strategy.
Circular construction / higher recycled content in buildings	Housing; closing supply chains / recycling	Core CE	Increases recycled content and reduces waste treatment needs; central CE construction measure.
Responsible / more efficient resource extraction	Cross-sectoral; process improvements in mining	Core CE	Improves efficiency in primary material extraction and directly affects the material base of the economy.
Circular vehicles / higher recycled content in vehicles	Mobility; closing supply chains / recycling	Core CE	Raises recycled content and supports circular design in vehicles.
Reuse of vehicle components	Mobility; product lifetime extension / reuse	Core CE	Extends component lifetimes through reuse; part of CE-oriented vehicle policy.
Extended lifetime of vehicles and other transport equipment	Mobility; product lifetime extension	Core CE	Slows loops by prolonging vehicle and transport asset lifetimes.
Lightweight vehicles and other transport equipment	Mobility; design improvements / lightweighting	Core CE	Reduces material input per unit of service via product re-design, aligned with CE-relevant product regulation.
Sharing and rental systems for vehicles	Mobility; sharing / use intensification	Core CE	Increases utilisation per vehicle and can reduce fleet turnover.
Higher vehicle occupancy / ride-sharing	Mobility; use intensification	Core CE	Raises occupancy, reducing the number of vehicles needed per passenger-kilometre.
Reduced car dependency (modal shift)	Mobility; demand reduction / mobility system change	Broad CE	Reduces car ownership and use, but primarily a mobility and climate strategy with circularity co-benefits.
Lightweight manufactured goods and equipment	Goods; design improvements / lightweighting	Core CE	Lowers material intensity of products through design changes.
Process improvements reducing material demand in manufacturing	Goods; process improvements / resource efficiency	Core CE	Reduces material demand in fabrication; complements other CE measures in production.
Repair and maintenance of textiles	Goods; product lifetime extension	Core CE	Extends textile lifetimes through repair; a prototypical CE repair measure.
Repair and maintenance of other durable goods	Goods; product lifetime extension	Core CE	Extends lifetimes of durable goods via repair and maintenance.
Extended lifetime of electrical appliances and equipment	Goods; delayed replacement	Core CE	Delays replacement via durability and repair, directly slowing material loops.

Intervention (short label)	Domain / main strategy	Final classification	Short reasoning
Sharing of office machinery, computers, furniture and other goods	Goods; sharing / use intensification	Core CE	Organises multi-user access to goods, reducing demand for new products.
Increased recycling / maximised recycling	Cross-sectoral; closing supply chains / recycling	Core CE	Substitutes primary with secondary materials and is a central pillar of CE policy.
Enhanced residual waste management (better treatment only)	Waste management; residual waste management	Not CE (foundational background)	Improves environmental performance of waste treatment, but does not in itself organise circular loops; treated as background.
Scrap diversion measures (sector-specific diversion to "other use")	Waste management; resource efficiency / scrap diversion	Not CE (replaced by generic recycling measure)	Mainly motivated by supply-security and industrial-policy concerns; logic unclear and better captured by a generic "maximise recycling" intervention.










## 5.4 Selection of interventions for modelling

This section outlines circular interventions contributing to a more circular economy used in the subsequent modelling. Note that only a subset of policy interventions could be included in the modelling exercise due to limited resources. A total of 17 CE interventions were included for modelling subsuming the majority of interventions reviewed in previous sections and providing a range of different CE strategy types (close, slow, narrow) and action fields (agri-food, mobility, housing, goods and consumables).

The interventions were sorted following the EEA's 'before use, during use and after use' framework (EEA, 2024):

- *Before-use actions* aim to meet societal needs with fewer natural resources and less impacts on environment and climate change. This includes making certain products redundant by delivering the same function differently, intensifying product use (e.g. through sharing models) and improving production processes to reduce resource inputs.
- *During-use actions* aim to maximise the lifetime and functionality of existing stocks once resources have been invested in products and infrastructure.
- *After-use actions* address end-of-life pathways by recovering materials from discarded products and returning them to the production cycle, preventing resource loss or destruction.

**Figure 5-1: Actions for increased circularity within the product chain**

BEFORE USE		REFUSE	Consider the necessity to acquire an additional product
		RETHINK	Design for longer lifetimes, repair and recycling or provide the function without making an additional product
		REDUCE	Produce the product with minimal environmental impact
DURING USE		RETAIN	Use and maintain existing products for a long service life
		REUSE AND SHARE	Provide products to others for further usage
		REPAIR	Fix defective products and return them to original functionality
		REMANUFACTURE	Rebuild products to deliver as-new, or upgraded, functionality
AFTER USE		RECYCLE	Process discarded products into useful, high-quality materials
		RETURN	Substitute virgin resources with secondary raw materials

Source: EEA (2024).

The following interventions have been identified from literature as key strategies for enhancing resource efficiency and promoting circularity across various provisioning systems. Each intervention targets specific stages of the product or service lifecycle, from pre-use design and production to during-use maintenance and after-use recycling. To provide a structured overview, interventions are categorized by their primary provisioning system, classified as either core or broad measures, and linked to their corresponding circular action, such as reducing, reusing, retaining, or recycling. This framework highlights both sector-specific and cross-sectoral approaches to minimizing environmental impact while supporting sustainable consumption patterns.

- **Minimize food waste** (Food | Core | Before use – reduce)  
Reduces losses along the food supply chain by improving production, processing, redistribution, and consumer practices so that less food is discarded and more is used efficiently.
- **Extend service lifetime of buildings** (Housing | Core | During use – retain)  
Keeps buildings in use longer through adaptive reuse, higher occupancy, and durable, flexible design, reducing the need for new construction and materials.
- **Reuse of building components (e.g., steel, aluminium and concrete)** (Housing | Core | During use – reuse and share)  
Recovers and reuses building components from existing structures to avoid demolition waste and reduce demand for virgin construction materials.
- **Increase resource efficiency in the mining sector** (Mining | Core | Before use – rethink)  
Improves extraction and processing efficiency to recover more value from mined materials while using less energy, water, and inputs per unit of output.
- **Extend product lifetime of vehicles** (Mobility | Core | During use – retain)  
Slows vehicle replacement by extending service life through durability, maintenance, refurbishment, and reuse of high-value components.

- **Reduce mass of new vehicles** (Mobility | Core | Before use – reduce)  
Lowers material use by lightweighting vehicles through improved design and material substitution while maintaining performance.
- **Promote car sharing** (Mobility | Core | Before use – rethink)  
Increases vehicle utilisation by enabling shared access, reducing the total number of vehicles needed to deliver the same mobility services.
- **Promote ride sharing** (Mobility | Core | Before use – refuse)  
Raises vehicle occupancy by pooling trips, reducing vehicle kilometres travelled, fuel use, and the need for vehicle ownership.
- **Reduce mass of new products (packaging, electronics, consumables)** (Goods and consumables | Core | Before use – reduce)  
Reduces material intensity of consumer goods and packaging through lightweighting, minimal design, and elimination of unnecessary materials.
- **Improve maintenance and repair of textiles** (Goods and consumables | Core | During use – retain/repair)  
Extends the useful life of textiles through repair and care, lowering replacement rates and demand for new textile production.
- **Extend product lifetime of electric and electronic appliances (EEA)** (Goods and consumables | Core | During use – retain)  
Keeps electronic devices in use longer via repair, refurbishment, modular design, and software support, reducing new sales and e-waste.
- **Reuse and share consumables** (Goods and consumables | Core | During use – reuse and share)  
Reduces production needs by enabling multiple users or repeated use of goods through sharing, rental, and refill systems.
- **Increase recycling and use of secondary raw materials** (all | Core | After use – recycle/return)  
Substitutes virgin materials with recycled inputs by improving collection, sorting, and recycling systems to close material loops.
- **Less resource intensive food system** (Food | Broad | Before use – refuse)  
Shifts diets from animal-based foods to plant-based alternatives to lower resource use and environmental impacts while maintaining current caloric intake.
- **Reduce average floor space** (Housing | Broad | Before use – reduce)  
Delivers housing and work functions with less floor area per person through efficient design and shared spaces, reducing construction and energy demand.
- **Shift towards wood-based construction** (Housing | Broad | Before use – rethink)  
Replaces carbon-intensive materials like concrete and steel with sustainably sourced wood to lower embodied emissions and store carbon.
- **Reduce car dependency** (Mobility | Broad | Before use – rethink)  
Decreases reliance on private car ownership by shifting mobility to public transport, active travel, and shared services, cutting vehicle and fuel demand.

More details on each intervention are available in Annex 10.1.

## 6 Modelling approach

### 6.1 Methodology

The **multiregional environmentally extended input-output (MR EEIO)** model FIGAROe3 (shortly FIGe3) is used for this modelling exercise (Cazcarro et al., 2025). MR EEIO models show the interdependencies between industries and within and between countries as well as between intermediate and final product producers and consumers. The model provides a useful toolbox for assessing social, environmental, and economy-wide impacts of the transition towards a more circular economy (Wiebe et al., 2019), avoiding a cut-off on (economic) flows. MR EEIO tables, like FIGe3, have the advantage of tracking the transformation of products at each step along the global supply chain and additionally capturing material flows and related impacts across increasingly fragmented international supply chains. The major benefit of the approach is that it considers the interactions between different sectors and final demand of the economy and captures the environmental, social, and economic effects of circularity interventions within a single model.

By incorporating explicit exogenous technological and demand change, it is possible to model direct and indirect effects of production and demand changes in a what-if scenario, but not to model the dynamic response of an economy, such as macro-economic price changes or systemic rebound effects (Wiebe et al., 2018). The use of expert-knowledge in the form of exogenous assumptions is considered superior to relying on formal methods to represent behaviours that make technological change endogenous (Wiebe et al., 2018) due to its transparency (Donati et al., 2020b). This approach gives the modeler a maximum degree of freedom, but also the responsibility of ensuring that the changes implemented are consistent in both a mathematical and a contextual way. It requires that any induced or rebound effects need to be exogeneous included in the modelling, to make sure it is included in the modelling results. Induced effects refer to secondary economic effects resulting from changes in spending or investments patterns caused by an initial change in economic activity. This includes shifts in employment levels as well as changes in firms operating surpluses. Referencing the circular flow of income, these effects can have a multiplier effect on the overall economy, amplifying the initial change in economic activity. Circular economy rebound (Zink et al, 2017<sup>7</sup>) refers to unintended environmental impacts that occur because of circular economy interventions.

Modelling CE interventions in an EE MRIO framework must be understood as a comparison between the status quo (results from the basic model) and a result in which the what-if scenario is achieved (results from the adjusted model, whether (or not) from the prospective IO-tables). The net effect of circularity interventions can be quantified by the difference between the two (i.e., BAU and the CE-scenario) calculation results. The net impact is assumed to represent a measure of the potential effect of a specific circularity scenario (Aguilar-Hernandez et al., 2018).

Exogenous changes can be applied either in the supply and use tables (e.g., Aguilar-Hernandez et al., 2018; Wiebe et al., 2018; Wiebe et al. 2019) or directly in the input-output tables (e.g., Donati et al., 2020). Modelling exogenous changes in the supply and use table system allow a more accurate implementation of changes. Based on the modified and balanced supply and use tables a new input-output table can be derived. Another option is to model exogenous changes directly in the input-output table system. This approach can be used to model broader economic changes, i.e. those that are less detailed or specific, and is often less time-consuming.

Aguilar-Hernandez et al. (2018) show, based on a literature review, that IO models are suitable to assess the effects of incorporating circularity interventions by adjusting final demand and technology coefficients (e.g., interindustry relations, factor inputs (e.g., labour and capital), and environmental/social intensity coefficients), although several restrictions are mentioned. When modelling an intervention (e.g.,

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<sup>7</sup> Zink, T. and Geyer, R. (2017), Circular Economy Rebound. *Journal of Industrial Ecology*, 21: 593-602. <https://doi.org/10.1111/jiec.12545>

increasing recycling, extending product life, reducing input coefficients) in an input-output model awareness should be given to the fact that changes in the economic structure are implemented in the model to subsequently assess the changes on material flows and environmental impacts. This modelling only shifts monetary flows which might miss actual changes in physical flows or material intensities, aggregation might hide variation in technologies or materials that are important to the intervention, static models may fail to capture dynamic responses (e.g., technology improvements, behavioural changes, price elasticity), and missing data or sector detail may lead to incomplete representation of the circular intervention.

## 6.2 Model

The monetary supply and use tables from the FIGAROE3 model cover 45 geographical areas plus one rest-of-the-world (FIGW1) region. Per region the model details 213 products and 176 industries (Cazcarro et al., 2025). Labour accounts detail total employment and employment broken down by gender and skill level. Energy accounts include primary energy supply and net energy use, while air emission accounts cover four types of greenhouse gases - CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and fluorinated gases - for both combustion and non-combustion processes.

The geographical areas covered by FIGAROE3 are the EU27 Member States and the individual countries Argentina, Australia, Brazil, Canada, Switzerland, China, Indonesia, India, Japan, South Korea, Mexico, Norway, Russia, Saudi Arabia, Turkey, United Kingdom, United States, and South Africa. In addition, one aggregated Rest-of-the-World region (FIGW1) is added to cover the full world economy.

The products classification in the FIGAROE3 model is linked to the CPA 2.1 nomenclature. The sector classification is linked to the NACE 2.1 nomenclature. The CPA product categories are related to the economic activities of the statistical classification of economic activities (NACE).

From inter-country supply and use tables, an inter-country industry-by-industry input-output table is created following the analytical transformation processes for deriving the input-output tables using the fixed product sales structure assumption (model D, (Eurostat, 2019)).

The FIGAROE3 extension table includes emission data on carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases (F-gases). This table contains data on air emissions by industries and direct emissions by households for 2015 in Gg per geographical area. These extension tables are supplemented with a wider coverage of environmental extensions available from the EXIOBASE v3.8.2 dataset (Stadler et al., 2025). These extensions are translated into the 16 environmental impact categories according from the Environmental Footprint (EF) method 3.1 (Andreasi et al., 2023). Translating the 528 unique environmental extension lines into the 16 impact categories of the EF-method requires a conversion through characterization factors. This allows to calculate 14 out of the requested 16 impact categories in the Environmental Footprint method. Ionising Radiation and Ozone Depletion are excluded because emissions related to these impact categories are missing (Beylot et al., 2019). In this study, we focus on the impact categories climate change (kg CO<sub>2</sub>-eq.) and particulate matter (disease inc.). Additionally, an impact category representing total land-use based biodiversity loss (global PDF) is added based on the Resolved Exiobase (REX3) model (Cabernard et al., 2024).

Each intervention is applied in two different models:

- A model representing the **current economic structure** is used reflecting the year 2020<sup>8</sup>. The size of the economy, consumption, the energy supply and use are close to the 2020 economic structure.

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<sup>8</sup> This is a modelled version of the economy in year 2020, produced by projecting the 2015 FIGAROE3 tables to the year 2020 based on the 2023 edition of the Global Energy and Climate Outlook (GECO) report published by DG JRC. This modelled version of the 2020 economy is not affected by the COVID-19 pandemic.

- A model representing a **low-carbon economic structure**. It is a representation of a possible future economy with a decarbonised energy system. It is a model building upon the NDC-LTS scenario for the year 2050 of the Global Energy and Climate Outlook (GECO) 2023 report. To align with the NDC-LTS scenario from GECO 2023 the FIGe3 supply and use tables are modified to reflect these possible future changes. These changes include an economic growth, population growth, changing energy system and emission intensities. A full description of the model is available in Wagner et al. (Wagner et al., 2025).

The three environmental impacts for climate change, particulate matter air pollution, and biodiversity loss highlighted in our report are calculated as follows:

- Climate change measures global temperature rise from greenhouse gas emissions (such as CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O), expressed in kg CO<sub>2</sub> equivalent (CO<sub>2</sub>eq) (Andreasi et al., 2023).
- Particulate matter (PM) quantifies respiratory and mortality risks to human health from fine particle emissions (PM<sub>2.5</sub> or less) and precursors like NO<sub>x</sub> and SO<sub>2</sub>, reported as disease incidence per kg emitted (Andreasi et al., 2023).
- Biodiversity loss uses Chaudhary et al. (2015)'s Countryside SAR model to calculate potentially disappeared fraction of species (PDF·m<sup>2</sup>·yr) from land occupation/transformation, accounting for ecoregion-specific vulnerability across five taxa (Chaudhary et al., 2015).

### 6.3 Limitations of the methodology

Scenario analysis based on environmentally extended multiregional input–output (EE-MRIO) tables is subject to several structural and methodological limitations that should be carefully considered when interpreting results. First, EE-MRIO models rely on fixed technical coefficients, implicitly assuming linear production functions and proportional relationships between inputs, outputs, and environmental extensions. Therefore, these models are limited in their ability to capture technological change, substitution effects, economies of scale, and behavioural responses that may occur under transformative policy scenarios. This static representation may overestimate or underestimate impacts when large structural changes are modelled.

Second, representing CE strategies, particularly those related to material quality and recycling, is challenging in EE-MRIO frameworks. While physical flows can be adjusted to reflect changes in for example recycling rates, the degradation of material quality, downcycling processes, and changes in functional equivalence are difficult to incorporate consistently. As a result, improvements in material circularity may be simplified or omitted, potentially biasing results towards conservative estimates of environmental benefits.

Third, the treatment of spill-over and displacement effects in EE-MRIO scenario modelling is inherently limited. Typically, only first-round spill-over effects within industries and regions are captured. For example, a reduction in production or exports in one region may lead to increased production in other regions to meet global demand. However, these substitution effects are often modelled in a simplified (linear) manner and may not fully reflect differences in production technologies, environmental intensities, or capacity constraints of alternative suppliers. This can lead to an underestimation of rebound or leakage effects at the global level.

Moreover, many EE-MRIO-based scenario analyses are conducted in a static framework, applying a single exogenous shock that represents the full implementation of a potential policy intervention. While this approach captures the long-run equilibrium effects of the scenario, it does not account for transition dynamics, adjustment costs, or path dependencies over time. Although dynamic extensions are

theoretically possible, particularly when combined with material flow analysis or time-series projections, they require substantial computational resources and detailed assumptions, which often limits their practical application.

Given these limitations, the results of the EE-MRIO scenario analysis should be interpreted with caution. Rather than providing precise quantitative forecasts, the modelling outcomes are best understood as indicative estimates that help to sketch the overall direction, order of magnitude, and relative importance of different effects across regions and interventions. The strength of the approach lies in its ability to capture economy-wide interdependencies and global supply-chain linkages, offering a coherent systems perspective on potential environmental implications. Consequently, the results are primarily intended to support exploratory analysis and comparative insights between scenarios, and not to serve as exact predictions of future outcomes.

## 7 Results

In this study we use a footprint perspective, which is different compared to a territorial or domestic impact perspective. A territorial impact perspective measures all impacts that occur within a region's borders — for example, all greenhouse gas emissions, land use, or pollution generated or used inside the EU-27. In contrast, a consumption footprint perspective accounts for the global impacts driven by what the region consumes, regardless of where production happens. This means it adds the environmental pressures embedded in imported goods and subtracts those tied to exports. As a result, the consumption footprint typically reveals a larger, more globally distributed impact for regions like the EU-27, which import many resource and impact-intensive products produced elsewhere (see Box 7-1 for more details).

### Box 7-1: Consumption footprint versus territorial/domestic impacts

In this report, the results focus on EU-27 consumption footprints. This includes global impacts that are linked to annual EU-27 consumption activities by final demand categories. These final demand categories include household expenditures, expenditures by non-profit institutions serving households, government spending on products for society (e.g., healthcare, defence), investments and changes in inventories. The consumption footprints are composed of:

- Indirect impacts of EU-27 include impacts from EU-27 production activities that are linked (directly or indirectly) to annual EU-27 final consumption. The complete production network of goods and services is considered (scope 2 + 3).
- Indirect emissions of the rest of the world (RoW) include impacts from non-EU-27 production activities that are linked (directly or indirectly) to annual EU-27 final consumption (scope 2 + 3).
- Direct impacts (scope 1) cover annual impacts directly generated by households (e.g., combustion in appliances for heating houses or during personal transport activities).

In the area of climate change, the IPCC reporting typically follows a production-based/territorial approach. A territorial approach includes all GHG emissions that occur within the regional (i.e. EU-27) territory. A consumption footprint approach allocates emissions based on the location where the goods and services are consumed. The overlap between the consumption footprint approach and territorial approach lies in the domestic (i.e., EU-27) impacts of activities linked to EU-27 consumption. The difference between both approaches are the impacts from domestic (EU-27) activities that are linked to extra-EU-27 exports, and impacts originating from the RoW linked to domestic (EU-27) consumption, which are not included in the IPCC approach.

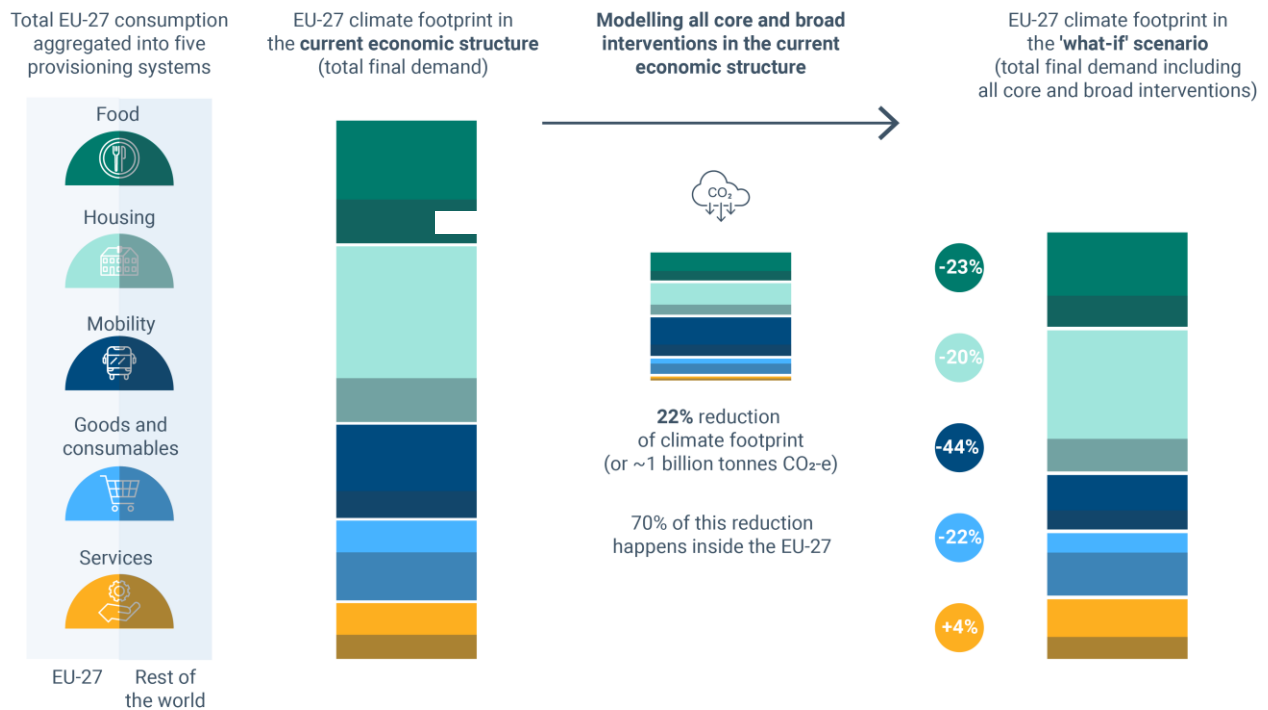
Another difference is related to the emissions included in the IPCC GHG emission inventories and the extension tables available in EE MRIO models. IPCC inventories include all major GHG that need to be reported such as CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and fluorinated gases while the EE MRIO extension tables often do not include fluorinated gases due to lack of data. Land Use, Land Use Change and Forestry (LULUCF) emissions and removals are included (separately) in IPCC inventories, but not in the EE MRIO extension tables.

Creating a what-if scenario that combines all the core and broad CE interventions into the current economic structure (year 2020, modelled based on FIGAROe3 and GECO 2023 data) results in an estimated reduction potential in the EU-27.

For climate change, the total **climate change footprint** is reduced by 22%, or 944 million tons CO<sub>2</sub>-eq (Figure 7-1). It means that in the current economic structure, the EU-27 greenhouse gas emission footprint would be 22% lower if all combined core and broad interventions were fully implemented at the high ambition level. 71% of this reduction occurs inside the EU-27 territory, either via a reduction in greenhouse

gas emissions by industries or by households. The remaining 29% are reductions in greenhouse gas emissions by non-EU-27 industries.

**Figure 7-1: Reduction in the climate change footprint of EU-27 consumption by combining all core and broad interventions (high ambition level) in the current economic structure, per provisioning system.**

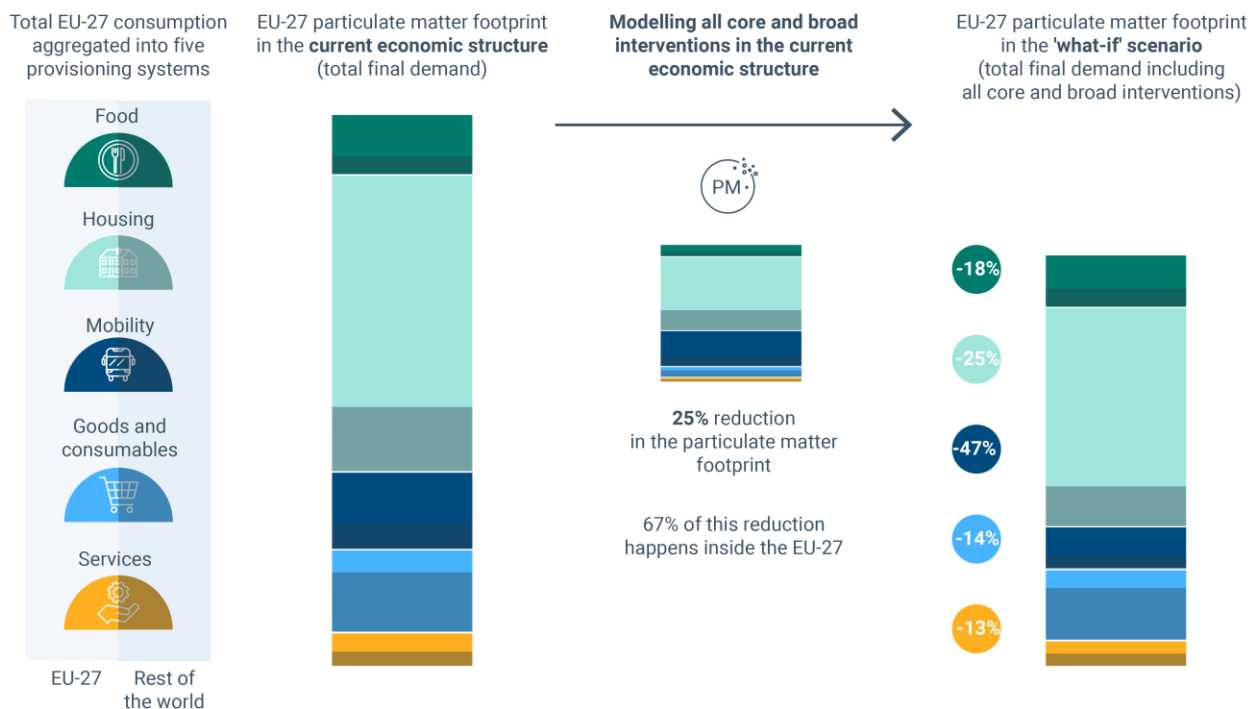


Source: ETC-CE, own calculations, EEA layout.

Note: The footprint is disaggregated into provisioning systems (colours) and the origin of emissions (coloured and shaded area). Impacts originating within the EU-27 are indicated by a coloured area; impacts originating outside the EU-27 are indicated by a shaded area. The modelling of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which all interventions are fully implemented (based on the high ambition level). The reduction share per provisioning system is indicated on the right, i.e., the reduction within the provisioning system. The overall reduction in the footprint is 22%.

The reduction potential in **particulate matter footprint**, measured via particulate matter emissions, is 25% or 40.5 thousand disease inc (Figure 7-2). It means that in the current system, the EU-27 pollution footprint would be 25% lower if all combined core and broad interventions would be fully implemented at the high ambition level. 67% of this reduction occurs inside the EU-27 territory, either via a reduction in emissions by industries or by final demand categories. The remaining 29% are reductions in emissions by non-EU-27 industries.

**Figure 7-2: Reduction in the particulate matter footprint of EU-27 consumption by combining all core and broad interventions (high ambition level) in the current economic structure, per provisioning system.**

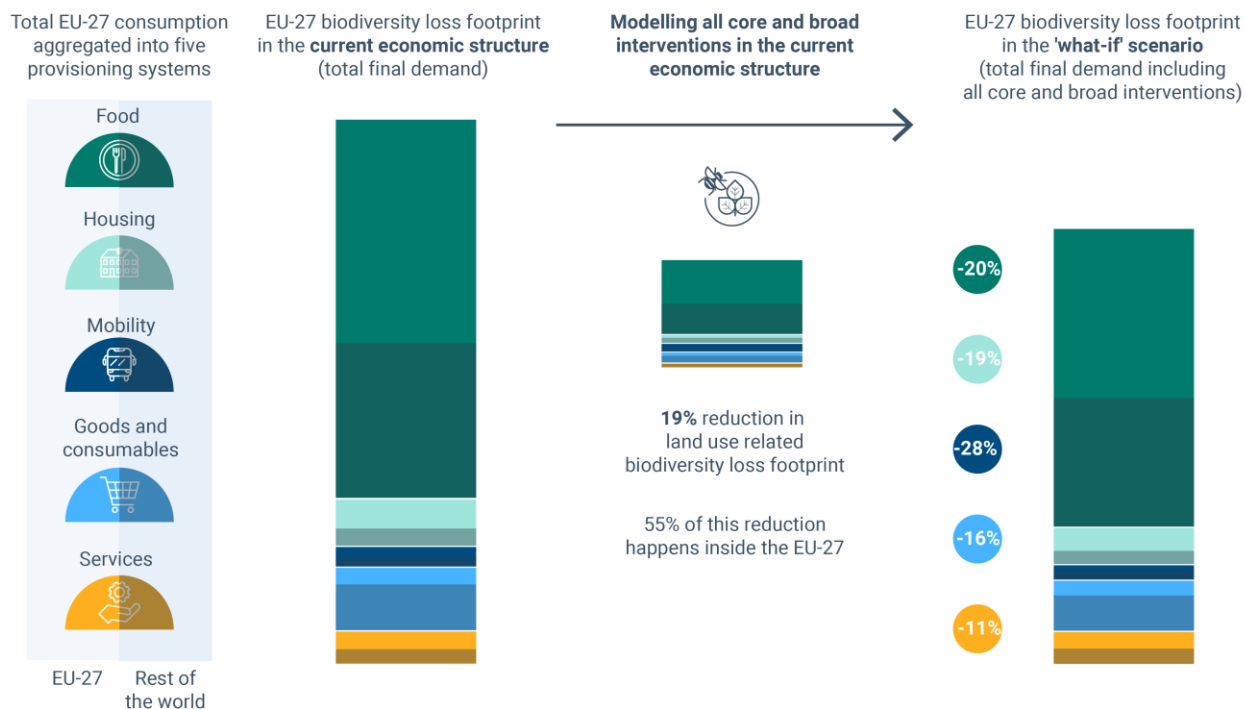


Source: ETC-CE, own calculations, EEA layout.

Note: The footprint is disaggregated into provisioning systems (colours) and the origin of emissions (coloured and shaded area). Impacts originating within the EU-27 are indicated by a coloured area; impacts originating outside the EU-27 are indicated by a shaded area. The modelling of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which all interventions are fully implemented (based on the high ambition level). The reduction share per provisioning system is indicated on the right, i.e., the reduction within the provisioning system. The overall reduction in the footprint is 25%.

The reduction potential in the **land-use related biodiversity loss** is 19%, or  $0.99 \times 10^{-3}$  (=0.00099) global pdf (Figure 7-3). It means that in the current economic structure, the EU-27 biodiversity footprint would be 19% lower if all combined core and broad interventions would be fully implemented at the high ambition level. 55% of the reduction occurs inside the EU-27 territory, while the remaining 45% occurs outside the EU-27.

**Figure 7-3: Reduction in the land-use related biodiversity loss footprint of EU-27 consumption by combining all core and broad interventions (high ambition level) in the current economic structure, per provisioning system.**



Source: ETC-CE, own calculations, EEA layout.

Note: The footprint is disaggregated into provisioning systems (colours) and the origin of emissions (coloured and shaded area). Impacts originating within the EU-27 are indicated by a coloured area; impacts originating outside the EU-27 are indicated by a shaded area. The modelling of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which all interventions are fully implemented (based on the high ambition level). The reduction share per provisioning system is indicated on the right, i.e., the reduction within the provisioning system. The overall reduction in the footprint is 19%.

Figure 7-1 to Figure 7-3 are disaggregated per provisioning system. Provisioning systems are categories that group the different types of goods and services purchased by end consumers (e.g., households) for their everyday needs and well-being. These domains help to understand spending patterns and track how consumption contributes to overall economic activity. In this report, we distinguish between five broad domains: essentials such as food and housing, as well as mobility, goods and consumables, and various services. By organizing expenditures this way, we can study per indicator (climate change, pollution, and biodiversity) how interventions can have different effects on each domain. These provisioning systems are typically related to sectoral policies, thus adding a layer of detail that is of relevance to policy makers.

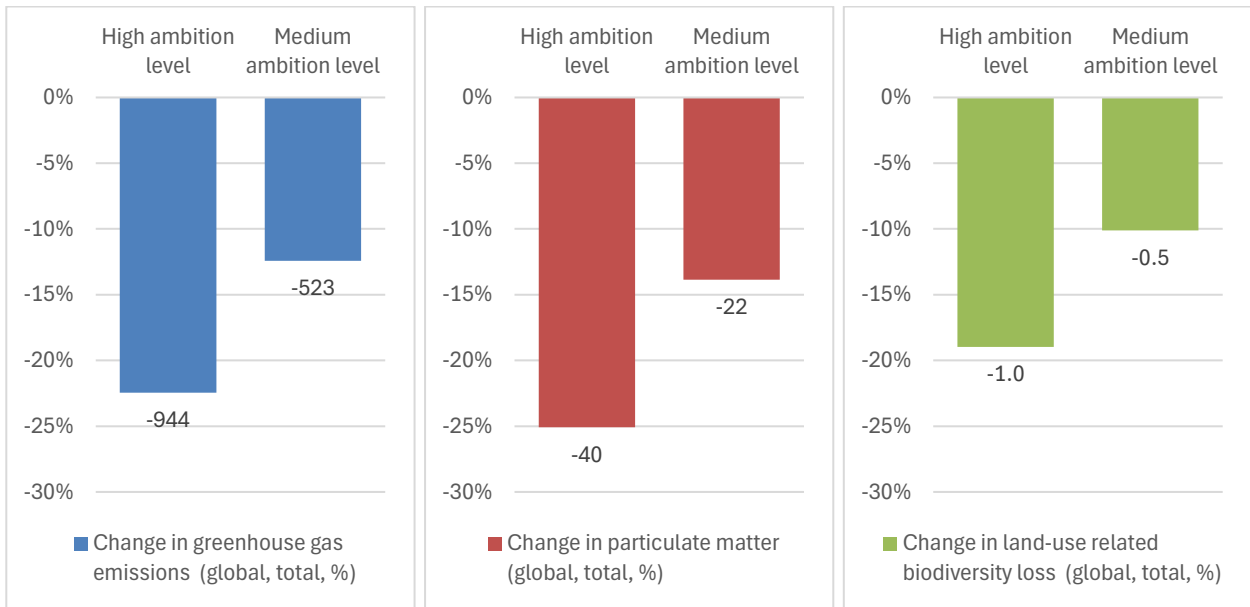
The results presented above are discussed in more detail in the sections below. Section 7.1 compares the results in case the CE interventions achieve a high versus medium ambition level, and the difference in potential in the context of the current economy (year 2020, modelled based on FIGAROe3 and GECO 2023 data) versus a potential future low-carbon economy (year 2050 under the NDC-LTS scenario of GECO 2023). The results are also disaggregated according to provisioning systems, core and broad interventions, and impacts inside and outside the EU-27. In Section 7.2, the results from the individual interventions are discussed. Section 7.3 provides some external validation of the results in comparison to other studies.

## 7.1 Results per dimension

### 7.1.1 Medium versus high ambition level

Each intervention is modelled as being implemented in our current economic structure using a high ambition level and a medium ambition level (Figure 7-4). High versus medium ambition levels represent optimistic vs. conservative implementation scenarios for each CE intervention, with varying reduction targets calibrated to policy goals and literature estimates. For example, "Minimize food waste" assumes high ambition at -40% waste reduction in food processing/manufacturing and -50% at retail/households/restaurants, while medium ambition applies -10% and -30% respectively. These levels adjust key modelling parameters like sectoral input reductions, final demand cuts, and emission intensities, with details provided in the annex. Achieving these ambition levels would require substantial changes to production and consumption, but how to achieve them is not within the scope of this study.

**Figure 7-4: Reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption by combining core and broad interventions at high ambition level or at medium ambition level in the current economic structure.**



Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in (10<sup>-3</sup>) global pdf). The modelling of the set of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (based on the high ambition level or the medium ambition level). The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario (current economy).

The results of the **different ambition levels** show considerable differences in case the high ambition levels are not achieved. Compared to the high ambition level, only achieving a medium ambition level for all interventions results in significantly lower environmental benefits. Only 55% for climate change, 55% for pollution, and 53% for biodiversity impact reductions remain compared to the reduction potential of the high ambition level.

This comparison highlights that the choice of ambition levels for CE policy interventions relates directly to the potential of these interventions to generate environmental benefits. At this stage, our modelling does not cover the socio-economic impacts of the CE interventions, which would be necessary to determine the socially optimal ambition levels of these interventions. However, our results clearly illustrate that the potential environmental benefits of CE interventions in the current economic structure are significant (10-

14% reduction of global environmental impacts at medium ambition levels, increasing to 19-25% at high ambition levels).

### 7.1.2 Current versus potential low-carbon economic structure

The combination of all core and broad interventions is modelled in two economic structures. First, all interventions are included in a representation of the **current economic structure (year 2020, modelled based on FIGAROE3 and GECO 2023 data)**. The modelling of all interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (at the high ambition level) to compare the effect on climate change, pollution and biodiversity relative to the current economic structure without these interventions.

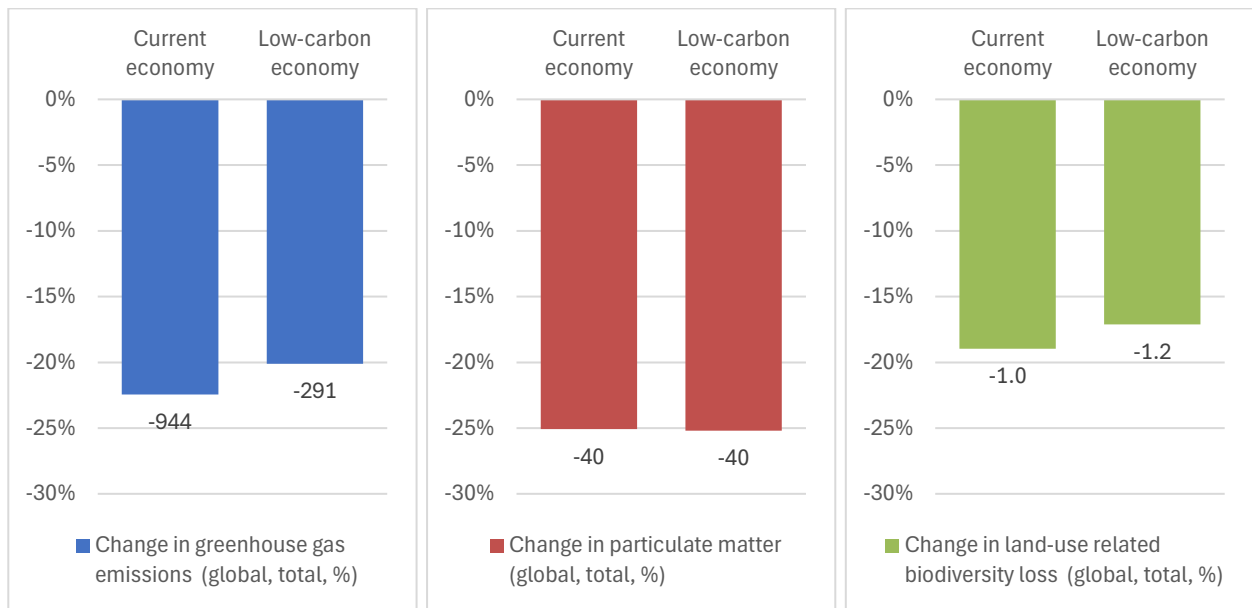
The second modelling of all interventions in a **potential future low-carbon economic structure** should be interpreted as a what-if scenario in which a set of interventions is fully implemented (at the high ambition level) to compare the effect on climate change, pollution and biodiversity relative to an economic structure that has undergone an ambitious energy transition by 2050. The baseline economic structure for this assessment is brought in line with the NDC-LTS scenario for 2050 from the Global Energy and Climate Outlook (GECO) report (see Section 6.2). As the modelled low-carbon economy is focusing on energy and closely related to greenhouse gas emissions, the interpretation of the two other indicators (air pollution and biodiversity) should be considered with more uncertainty.

When the CE interventions are implemented in a low-carbon economy, their potential effect on climate change in absolute terms is much smaller compared to their implementation in the current economy (291 versus 944 million tons CO<sub>2</sub>-eq.). In relative terms, however, the reduction potential is similar across the two systems, at 22% in the current economy and 20% in the low-carbon economy. This is because GHG emissions in the low-carbon economy baseline (without implementation of the CE interventions) are also much lower than those in the baseline of the current economy. The energy system in the low-carbon economy is already much less GHG-intensive, which means that the additional benefit of CE interventions that reduce energy consumption is also much lower in absolute terms.

The transition to a low-carbon economy mostly affects climate change savings. For air pollution and biodiversity, the differences in absolute terms between the current economy and the low-carbon economy to their respective baselines are much smaller. For particulate matter, the difference is -40.5 thousand disease inc. in the context of the current economy and -40.3 thousand disease inc. in the low-carbon economy. For land-use related biodiversity loss, the difference is -0.99 (10<sup>-3</sup>) global pdf in the context of the current economy and -1.23 (10<sup>-3</sup>) global pdf in the low-carbon economy. In relative terms, for particulate matter the reduction is equal in both types of economy (25%), while for land-use related biodiversity loss the reduction when all CE interventions would have been implemented is 19% in the current economy and 17% in a low-carbon economy.

Note that for biodiversity, the absolute reduction potential of the modelled CE interventions is larger in the context of a future low-carbon economy than in the current economy. This is because factors such as population and GDP growth have been accounted for in the modelling of the 2050 low-carbon economic structure, but no fundamental change to the land-use intensity of economic sectors was modelled (in contrast to the fundamentally changed energy system). While the lower percentual difference to the baseline in the low-carbon economy indicates that there is a limited spill-over effect of the changed energy system (due to a shift to energy sources with lower land use change impacts), the growth of the total economic structure results in an increase in the absolute reduction potential for biodiversity impacts in the future low-carbon economic structure (in contrast to the GHG and particulate matter impacts).

**Figure 7-5: Reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption by combining core and broad interventions (at high ambition level) in the current economic structure (year 2020, modelled) and a low-carbon economic structure (year 2050), relative to their respective baselines.**



Source: ETC-CE, own calculations.

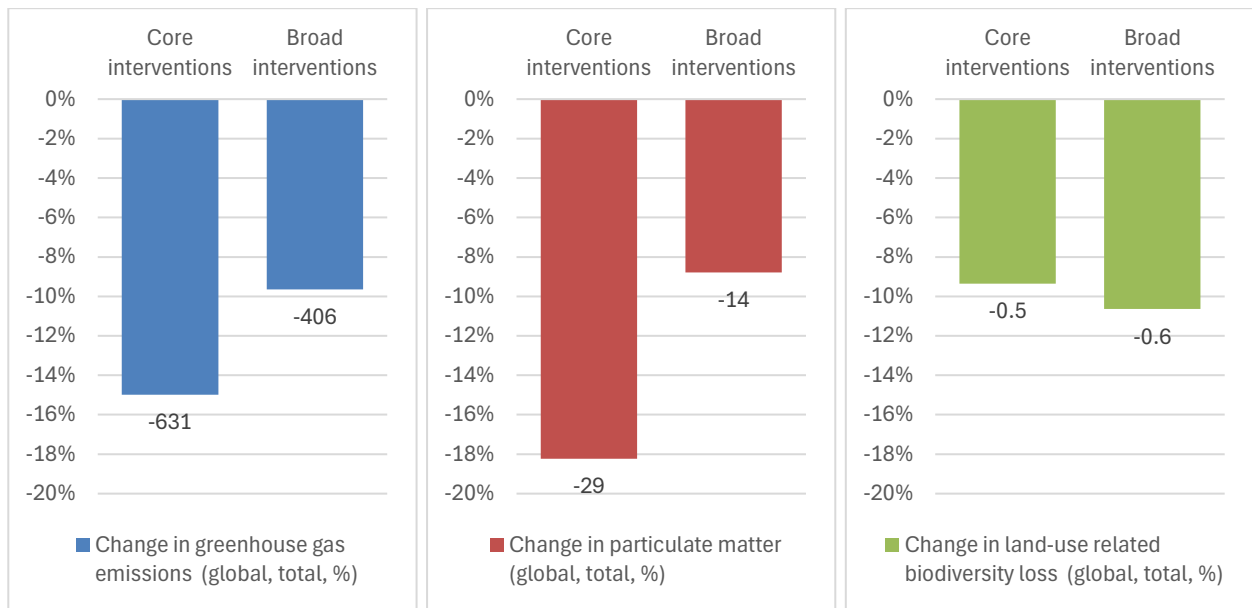
Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in (10<sup>-3</sup>) global pdf). The modelling of the set of all core and broad interventions in the current economic structure (year 2020, modelled based on FIGAROE3 and GECCO 2023 data) and a low-carbon economic structure (year 2050) should be interpreted as a what-if scenario in which a set of interventions is fully implemented at the high ambition level. The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario of the respective economic structures.

### 7.1.3 Disaggregation in core and broad interventions

As the scope assessment of CE interventions was an important preparatory step to modelling their impact reduction potential, this section presents the reduction potential of only the **core interventions** and the reduction potential of only the **broad interventions**. The discussion in this section focuses on the results of the what-if scenario in which the CE interventions are implemented at high ambition level in our current economic structure. Note that these modelling results do not sum exactly to the overall modelling results, (i.e., the results of the combination of all core and broad interventions) due to overlap in effects from the interventions.

This study assesses a total of 17 CE interventions. Of these, 13 are identified as core CE interventions, and four as broad CE interventions. Both sets have considerable impact on climate change, air pollution and biodiversity loss, even though the number of interventions in the broad category is significantly more limited than that in the core category. When implemented at high ambition level in the current economic structure, the combined 13 core interventions trigger a reduction in the EU-27 consumption footprint of 631 million tons CO<sub>2</sub>-eq. (greenhouse gas emissions; 15% reduction relative to the baseline), 29.4 thousand disease inc. (particulate matter; 18% reduction), and 0.49 (10<sup>-3</sup>) global pdf (land-use related biodiversity loss; 9.4% reduction). The combined four broad interventions trigger a GHG impact reduction of 406 million tonnes CO<sub>2</sub>-eq. (9.6% reduction relative to the baseline), a particulate matter impact reduction of 14.2 thousand disease inc. (8.8% reduction), and a biodiversity impact reduction of 0.54 (10<sup>-3</sup>) global pdf (10.6% reduction).

**Figure 7-6: Reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption by combining core interventions and combining broad interventions (all at high ambition level) in the current economic structure.**



Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in (10<sup>-3</sup>) global pdf). The sum of the results from the core and broad interventions do not equal the overall results (in which the core and broad interventions are combined), due to overlap in effects from interventions. The modelling of the set of all core and a set of all broad interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (based on the high ambition level). The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario (current economy).

Considering the number of interventions in both categories, the average reduction potential per intervention is higher for the broad CE interventions than for the core CE interventions. This is because the broad CE scope includes far-reaching interventions like a dietary shift towards a less resource intensive food system, reducing average floor space of residences, changing construction practices towards more wood-based construction, and reducing car dependency (modal shift). These are all before-use circular actions which require considerable behavioural changes of end consumers, but the modelling results show that these can generate significant environmental savings when implemented at a high ambition level in an economic structure that is similar to the current one.

While the average impact per intervention is higher for the broad CE interventions, the core CE interventions have a higher combined reduction potential for two of the three assessed impact categories (greenhouse gas emissions and particulate matter). However, for biodiversity the combined reduction potential of the few broad interventions is larger than the combined effect of the core interventions. Most of this reduction potential can be attributed to one intervention, namely the intervention on promoting a less resource intensive food system (a dietary shift in which meat consumption is strongly reduced in favour of other food products). Section 7.2 contains a more elaborate comparison of the impacts of individual CE interventions, including an assessment of driving factors behind these results.

**Core interventions** that contribute most to the climate change reduction potential are increasing ride sharing, extending the useful service life of buildings, and increasing the reuse of building components. The same interventions contribute most to the reduction potential for particulate matter, but the housing-related interventions contribute more than the ride sharing intervention. Reduction potential for biodiversity is mainly coming from the CE interventions targeting the food system, which is represented in

the set of core interventions by the intervention on minimizing food waste. Other core interventions contributing most to the biodiversity impact reduction potential, are increased recycling and the use of secondary raw materials, as well as increasing maintenance and repair of textile products.

**Broad interventions** with the largest reduction potential for the climate change indicator are promoting a less resource intensive food system (a dietary shift in which meat consumption is strongly reduced in favour of other food products) and reducing car dependency (modal shift). For particulate matter, reducing the average floor space of residences and reducing car dependency are the broad interventions with the biggest impact reduction potential. In terms of preventing land-use related biodiversity loss, the broad intervention on promoting a less resource intensive food system is by far the most impactful one.

#### 7.1.4 Disaggregation in provisioning systems

Total consumption is disaggregated into five broad **provisioning systems**. These are categories that group the different types of goods and services purchased by end consumers into housing, food, mobility, goods and consumables, and services. None of the CE interventions target the provisioning system of services directly. The interventions in the mining category (resource efficiency improvements in the mining sector; increased recycling and use of secondary raw materials) do not directly link to any provisioning system but influence all of them indirectly. The discussion in this section focuses on the results of the what-if scenario in which the CE interventions are implemented at high ambition level in our current economic structure.

Figure 7-7 shows the environmental impact reduction potential of CE interventions targeting specific provisioning systems. Note that this figure shows the impact reductions modelled as the combination of interventions per provisioning system. These results do not sum exactly to the overall modelling results (i.e., the combined effect of all core and broad interventions) due to overlap in the effects of individual interventions.

Focusing first on the greenhouse gas emission reduction potential of the grouped CE interventions, it is the largest for the provisioning system mobility (-325 million tons CO<sub>2</sub>-eq.; equivalent to a 7.7% reduction relative to the current economy baseline), followed by housing (-277 million tons CO<sub>2</sub>-eq.; 6.6% reduction) and food (-219 million tons CO<sub>2</sub>-eq.; 5.2% reduction). Expressed as percentages relative to the total greenhouse gas emissions reduction potential of the four provisioning systems that are targeted directly by the modelled CE interventions (excluding services and mining), the mobility-related CE interventions account for 33.8% of the reduction potential, the housing-related interventions for 28.8%, the food-related interventions for 22.8%, and the interventions targeting goods and consumables for 14.6%.

Next, the particulate matter reduction potential is the largest for the provisioning system housing (-21.9 thousand disease inc.; equivalent to a 13.5% reduction relative to the current economy baseline), followed by mobility (-11.4 thousand disease inc.; 7.1% reduction). Expressed as percentages relative to the total particulate matter reduction potential of the four provisioning systems that are targeted directly by the modelled CE interventions, the housing-related CE interventions account for 52.9% of the reduction potential, the mobility-related interventions for 27.6%, the interventions targeting goods and consumables for 12.7%, and the food-related interventions for 6.8%.

Last, the land-use related biodiversity reduction potential is the largest for the provisioning system food (-0.66 (10<sup>-3</sup>) global pdf; equivalent to a 12.7% reduction relative to current economy baseline), followed by other goods and consumables (-0.24 (10<sup>-3</sup>) global pdf; 4.6% reduction). Expressed as percentages relative to the total biodiversity loss reduction potential of the four provisioning systems that are targeted directly by the modelled CE interventions, the food-related CE interventions account for 64.6% of the reduction potential, the interventions targeting goods and consumables for 23.3%, the housing-related interventions for 7.0%, and the mobility-related interventions for 5.1%.

Figure 7-7 illustrates that the impact reduction potential of CE interventions targeting specific provisioning systems differs across the three environmental impact categories that were assessed: mobility-related interventions have the largest greenhouse gas emissions reduction potential, while housing-related interventions have the largest particulate matter reduction potential, and food-related measures have the largest biodiversity loss reduction potential. This means that CE interventions targeting specific provisioning systems can be chosen deliberately to achieve specific types of environmental benefits, but also that a balanced set of CE interventions can be selected to create environmental savings across multiple impact categories simultaneously. Section 7.2 contains a more elaborate comparison of the impacts of individual CE interventions, including an assessment of driving factors behind these results.

Another observation from Figure 7-7 is that the impact reduction potential of CE interventions can be either relatively balanced across provisioning systems or relatively concentrated in interventions targeting a specific provisioning system, depending on the environmental impact category. In terms of greenhouse gas emissions reduction potential, the contribution of CE interventions targeting specific provisioning systems is relatively balanced. However, the reduction potential for particulate matter is more concentrated (with a significant contribution coming from housing-related CE interventions) and for biodiversity loss, the reduction potential is highly concentrated in food-related CE interventions.

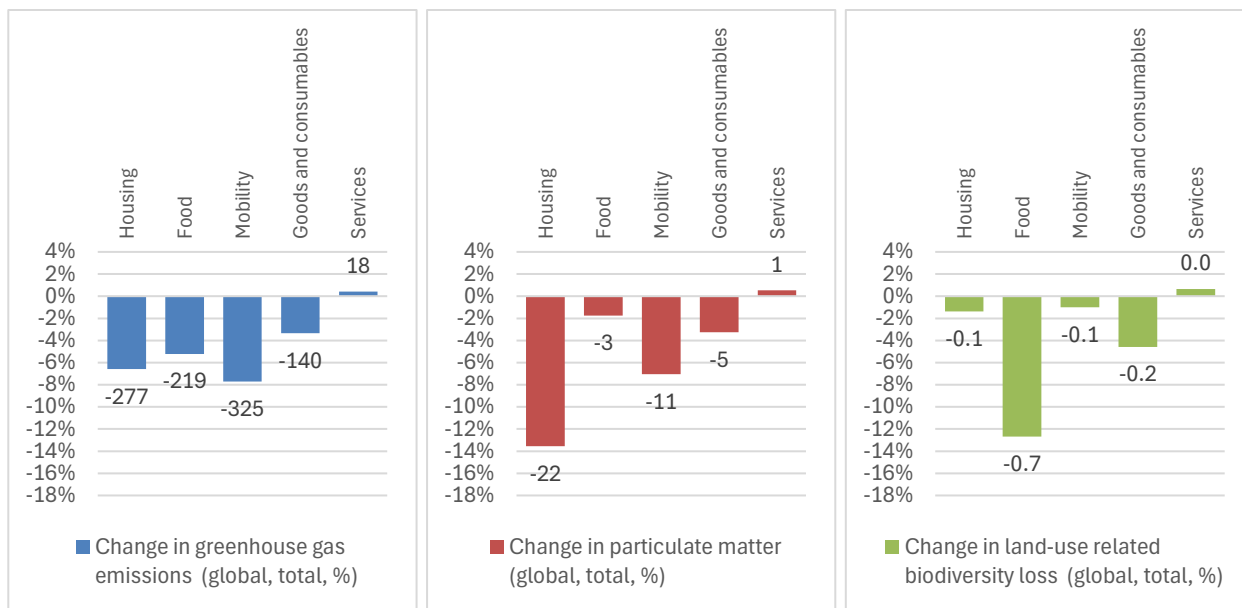
While a detailed comparison of individual CE interventions is the subject of Section 7.2, we highlight here the key contributing interventions of the four provisioning systems that are targeted directly by the modelled CE interventions. For the provisioning system **mobility**, the largest reduction potential comes from increased ride sharing (use intensification; core intervention) and reduced car dependency (modal shift; broad intervention). These interventions mainly generate environmental benefits in the climate change and particulate matter impact categories. CE interventions targeting mobility have a limited impact on land-use related biodiversity loss relative to other interventions.

For the provisioning system **housing**, the largest reduction potential for climate change impacts is achieved by the interventions on extending the useful service life of buildings and the reuse of building components (both core interventions). The most significant reduction for particulate matter is achieved by the interventions on extending the useful service life of buildings (core) and the reduction of the average residential floor space (broad). CE interventions targeting housing have a limited impact on land-use related biodiversity loss relative to other interventions.

Only two **food**-related CE interventions were modelled in this study. Promoting a less resource intensive food system (dietary shift; broad intervention) is the leading intervention in terms of impact reduction potential for both climate change and biodiversity loss but is of limited significance for the particulate matter impact category relative to other interventions. Minimizing food waste (core intervention) is the second most promising CE intervention for reducing land-use based biodiversity loss but is of limited significance for the climate change and particulate matter impact categories relative to other interventions.

Interventions targeting **other goods and consumables** are generally of moderate to low significance for the three impact categories assessed in this study. However, the intervention on reducing the mass of new products has considerable impact reduction potential for the climate change and particulate matter impact categories, while the intervention on increasing the maintenance and repair of textiles does rank in the top five interventions when looking at biodiversity loss reduction potential.

**Figure 7-7: Reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption by combining core and broad interventions at high ambition level in the current economic structure, disaggregated into provisioning systems.**



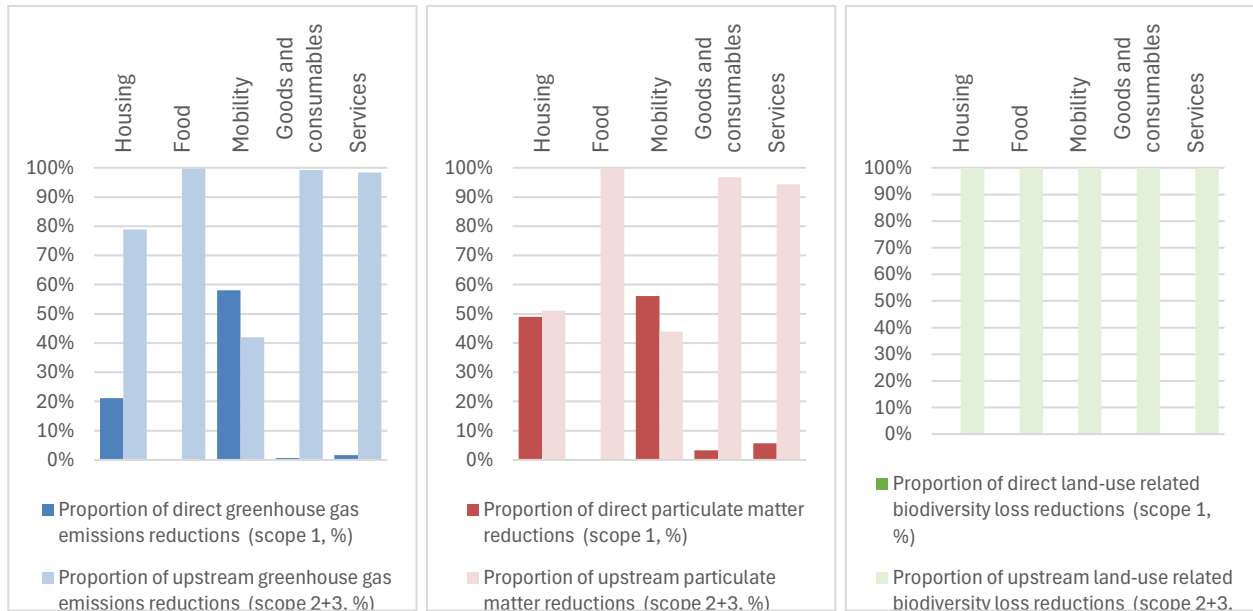
Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in 10<sup>-3</sup> global pdf). The modelling of the set of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (based on the high ambition level). The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario (current economy).

The footprint per provisioning system can also be disaggregated into direct emissions caused by end users during the use phase (e.g., fuel combustion for residential heating or driving a car; conceptually similar to scope 1 emissions) and indirect emissions triggered by the consumption of end users but occurring upstream along the value chain (comparable to combined scope 2 and scope 3 emissions). For this study, we did model direct impacts for the greenhouse gas emissions and particulate matter impact categories, but not for land-use related biodiversity loss. In other words, for the indicator on biodiversity, only upstream impacts occur in our modelling.

Figure 7-8 shows the breakdown into direct and indirect impact reduction potential per provisioning system and impact category. The share of the impact reduction potential linked to direct emissions caused by end users during the use phase is 58.1% for mobility and 21.1% for housing when looking at the greenhouse gas emissions impact category. For particulate matter, these shares are 56.1% for mobility and 48.9% for housing. In other words, for climate change, but especially for particulate matter, a significant part of the impact reduction potential of the modelled CE interventions in the domains of housing and mobility occurs during the use phase, by reducing the need for fuel for residential heating and personal mobility. As such, these CE interventions have the potential to generate local environmental benefits (within the EU-27 Member States) and reduce the population’s dependence on fossil fuels, at least within the context of our current economic structure. The next section elaborates on the distinction between impacts occurring within the EU-27 or in the rest of the world.

**Figure 7-8: Share of direct impacts caused by end consumers during the use phase versus indirect impacts occurring along the value chain in the reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption (combining core and broad interventions at high ambition level in the current economic structure), disaggregated into provisioning systems.**



Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in (10<sup>-3</sup>) global pdf). The impacts originating in households directly (scope 1) are indicated in dark colour; impacts originating in the upstream supply chain are indicated in light colour. The modelling of the set of all core and broad interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (based on the high ambition level). The proportion of direct and upstream footprint reduction in the total reduction is given.

### 7.1.5 Disaggregation in EU-27 and RoW

Value chains in the current economic structure are global and, as such, environmental impacts caused by EU-27 consumption occur both in and outside of the EU. Consequently, the CE interventions also reduce environmental impacts within and outside of the EU. In this section, the total reduction potential of all CE interventions is disaggregated between the geographical areas where this reduction takes place: either in the EU-27 or in the Rest of the World (RoW). The discussion in this section focuses on the results of the what-if scenario in which the CE interventions are implemented at high ambition level in our current economic structure. While the scope of this report is limited to an assessment of three environmental benefits categories (climate change, air pollution, and biodiversity loss), circular economy interventions also contribute to saving natural resources and have the potential to reduce the dependence of the EU-27 on material extraction in other world regions. This aspect is briefly discussed in Box 7-2.

Figure 7-1 through Figure 7-3 illustrate that the implementation of all CE interventions combined leads to a reduction of 22% for climate change, 25% for particulate matter and 19% for land-use based biodiversity loss. Figure 7-9 shows the breakdown of these percentages into the part that occurs within the EU-27 and the part that occurs in the Rest of the World. In the case of the greenhouse gas emissions impact category, the 22% reduction relative to the baseline breaks down into almost 16% taking place within the EU-27 and a bit less than 7% occurring in the Rest of the World. For particulate matter, the distribution is similar, with an impact reduction of about 17% relative to the baseline occurring within the EU-27 versus a bit more than 8% occurring in the Rest of the World. For land-use based biodiversity loss, the total impact reduction

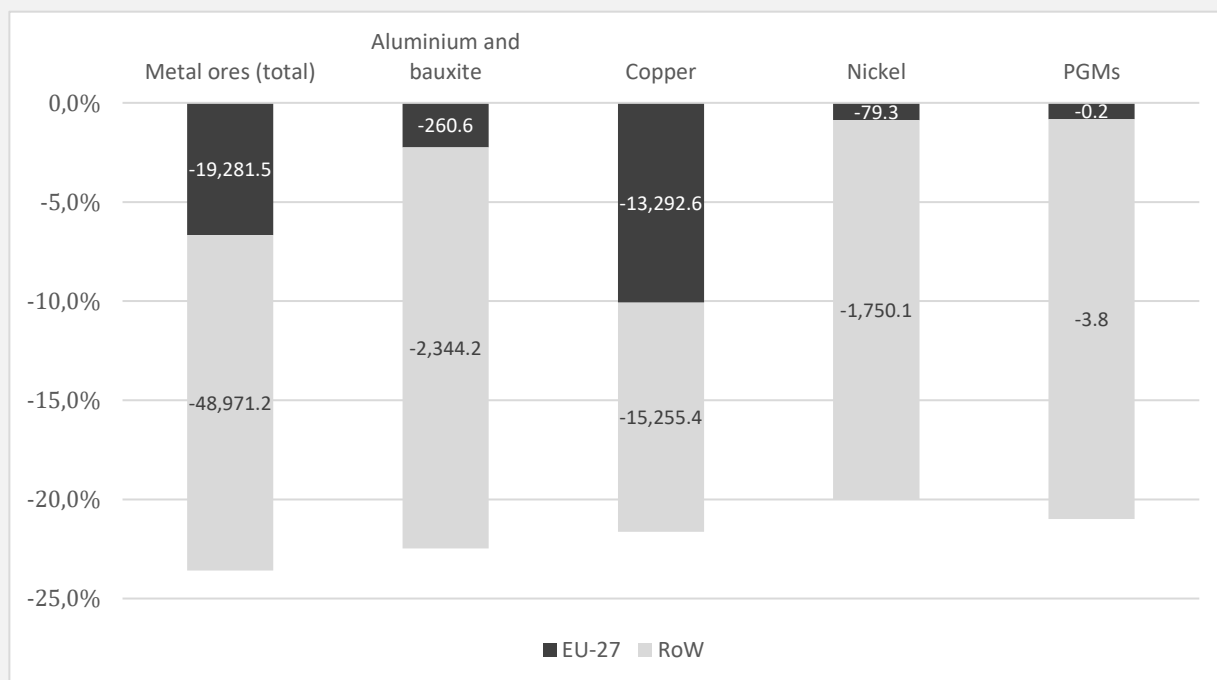
of 19% relative to the baseline breaks down into a bit more than 10% occurring in the EU-27 and a bit more than 8% occurring in the Rest of the World.

**Box 7-2: Potential of CE interventions to reduce EU-27 reliance on foreign extraction of metal ores**

Apart from reductions in greenhouse gas emissions, particulate matter, and biodiversity loss, the CE interventions modelled as part of this study also affect other environmental impact categories. One dimension of interest is the extraction of natural resources, either in the EU-27 or in other world regions. The figure below shows how a full implementation of the combined core and broad CE interventions in the current economic structure (at high ambition level) results in reductions in the metal ore footprint (in kilotonnes) linked to EU-27 consumption.

The results indicate a significant potential of the modelled CE interventions to reduce the extraction of metal ores (-68,000 kilotonnes, or -23.6% relative to the current economy baseline). This reduction occurs mostly outside of the EU-27: the CE interventions can save nearly 50,000 kilotonnes of metal ore extraction in other world regions (71.7% of the total reduction), thus lowering the dependence of the EU-27 on metal ores extracted elsewhere.

While the scale of extraction differs for specific types of metal ores, the reduction relative to the baseline is on the order of -20% for each of the four selected types of metal ores. However, the share of the reduction occurring inside or outside the EU-27 varies across metal ore types. For copper, the division between the EU-27 and the Rest of the World is nearly 50-50, whereas a much larger share of the reduction occurs outside of the EU-27 for aluminium/bauxite, nickel, and platinum group metals (PGMs) - on the order of 90% or more. Despite this variation across metal ore types, our results clearly illustrate that the modelled CE interventions have significant potential to reduce the reliance of the EU-27 on metal ore extraction occurring in elsewhere in the world.



Source: ETC-CE, own calculations

Note: Footprint approach for metal ores (domestic extraction used, for a total of 12 types of metal ores and a selection of individual metal ores, in kilotonnes). Modelling results of the what-if scenario in which the combined set of all core and broad interventions are fully implemented in the current economic structure at the high ambition level. The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario (current economy).

Figure 7-9 shows that most of the environmental impact reduction happens in Europe for each of the assessed environmental impact categories, but that the distribution differs depending on the impact category. For climate change and particulate matter, over two-thirds of the impact reduction would take place within the EU-27. For land-use based biodiversity loss, the distribution is closer to 50-50, even though most of the impact reduction would still occur within the EU (about 55%). The difference in the EU-27-RoW division across the impact categories is linked to whether the CE interventions contribute to reducing direct impacts caused by end consumers during the use phase (see also Figure 7-8). While end users do directly contribute to the emission of greenhouse gasses and particulate matter through the combustion of fuel for heating and personal mobility, no direct land-use impacts are attributed to them in our modelling. Moreover, land-use based biodiversity loss is strongly related to agricultural and food production activities, which are associated with higher biodiversity impacts when they occur in more biodiverse world regions.

While a detailed comparison of individual CE interventions is the subject of the next section, we briefly cover here which CE interventions have the largest impact reduction potential inside of the EU-27, for each of the environmental impact categories.

In terms of the climate change impact reduction, the following CE interventions save most inside the EU-27, ranked from largest to smallest reduction potential:

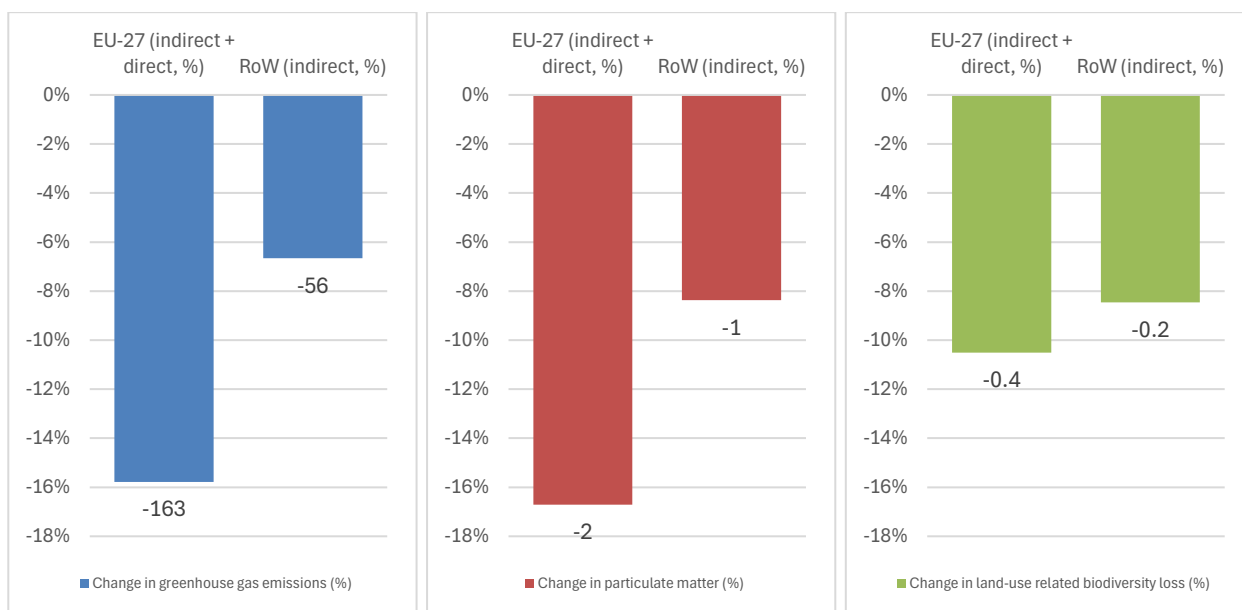
- Less resource intensive food system;
- Increase ride sharing;
- Reduce car dependency;
- Extend the life time of buildings;
- Reuse of building components;
- Reduction of average floor space.

Most CE interventions have more climate change reduction potential within the EU rather than outside it, although there are some exceptions. The CE interventions on reducing the mass of new products, increasing maintenance and repair of other goods and consumables, and increasing the reuse and sharing of other goods and consumables are associated with higher impact reduction potential in the Rest of the World. This relates to the fact that many of the other goods and consumables are produced in global production systems in which a large part of the value chain is located outside of the EU-27. As such, any reduction in the production of these goods leads mostly to benefits outside of the EU. For the interventions with higher impact reduction potential within the EU, either a larger part of the activities in the value chain are based in the EU (e.g., for the intervention on promoting a less resource intensive food system), or they affect the extent to which end consumers cause direct impacts during the use phase. For the mobility-related interventions, for example, a large share of the impacts are caused by the use of the vehicles (fuel consumption in the EU) relative to the impacts caused by their production (worldwide).

The situation for the reduction potential of particulate matter is comparable. The same CE interventions contribute most to the reduction in EU, except the less resource intensive food system intervention which has a less significant effect on the reduction of particulate matter in Europe than it has on greenhouse gas emissions.

With respect to the reduction of land-use based biodiversity loss in the EU-27, the intervention on a less resource intensive food system (dietary shift) does have the largest impact reduction potential by far, followed by minimizing food waste and increased recycling and use of secondary raw materials. Note, however, that the CE interventions targeting the food system also have a significant reduction potential in the Rest of the World.

**Figure 7-9: Reduction in the climate change, particulate matter, and biodiversity footprint of EU-27 consumption (combining core and broad interventions at high ambition level in the current economic structure), disaggregated into geographical region of impact.**



Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity loss (land-use related biodiversity loss, in 10<sup>-3</sup> global pdf). The impacts originating within the EU-27 are compared to the impacts originating outside the EU-27. The modelling of the location of impacts of all core interventions in the current economic structure should be interpreted as a what-if scenario in which a set of interventions is fully implemented (at high ambition level). The percentage change is presented on the Y-axis and the absolute difference is included in the bar labels, always compared to the baseline scenario (current economy).

## 7.2 Results per intervention

This section provides an overview of the results of modelling individual interventions separately, at high ambition level in the context of the current economic structure. The potential environmental impact reductions are shown for climate change (blue), air pollution (red), and for biodiversity (green) in Figure 7-10. The reduction potential of individual interventions differs across the indicators. Note that the impacts of individually modelled interventions do not sum to the totals of the combined scenarios due to overlapping effects when multiple interventions are combined.

The highest reduction potential for **greenhouse gas emissions** stems from promoting a less resource intensive food system (-190 million tons CO<sub>2</sub>-eq. or -4.5% relative to the baseline), ride sharing (-163 million tons CO<sub>2</sub>-eq.; -3.9%), extending the useful service life of buildings (-146 million tons CO<sub>2</sub>-eq.; -3.5%), reducing car dependency (-139 million tons CO<sub>2</sub>-eq.; -3.3%), and increasing the reuse of components in construction (-101 million tons CO<sub>2</sub>-eq.; -2.4%). These top interventions align with key EU policies such as the Farm to Fork Strategy for nutrition shifts, Sustainable and Smart Mobility Strategy for ride sharing/car reductions, Ecodesign for Sustainable Products Regulation (ESPR) and Circular Economy Action Plan (CEAP) for housing lifetime/reuse.

Promoting a less resource intensive food system is one of the broad CE interventions in which demand for animal farming and the processing of meat is significantly reduced for both end consumers and the hotel and restaurant sector and is partially offset by increased demand for the cultivation of grains, fruits, nuts, vegetables and other crops and the processing of non-meat food products (based on caloric intake). 87% of the reduction in GHG is linked to the changing consumption pattern of end consumers, favouring less GHG-intensive food products over the more GHG-intensive meat products, and its consequential impacts

along the value chain. The EU Farm to Fork Strategy<sup>9</sup> pushes for plant-based diets with less red/processed meat to cut food system GHGs, nutrient pollution, and biodiversity loss, and the Waste Framework Directive, as amended in 2025, sets binding food waste reduction targets v<sup>10</sup>.

The GHG-reductions of the mobility-related interventions, ride sharing and reducing car dependency, are both mainly related to avoided GHG-emission during the use phase (i.e., direct emissions attributed to end users), which account for about 68% of the GHG-emission reduction in both cases. While there is a subtle difference between these interventions (use intensification in the case of ride sharing, refusing car ownership in the case of reduced car dependency), their implementation in the modelling is similar, i.e. reduced demand for both fuel and motor vehicles combined with a reduction in the direct emissions of end users linked to fuel consumption. Both align with the Sustainable and Smart Mobility Strategy's<sup>11</sup> 90% transport GHG cut by 2050 via shared/collective modes, zero-emission vehicles, modal shifts from private cars, and urban planning for efficient connectivity.

While the mechanisms of the two housing-related interventions are different, the pathways of their ultimate GHG-reductions are similar. The intervention on extending the useful service life of buildings results in reduced demand for activities of the construction sector, both by intermediate consumers (other industries) and end consumers. The reduction in demand for construction by end consumers accounts for 68% of the total GHG-reduction of this intervention via indirect effects along the value chain, namely reductions in demand for GHG-intensive construction materials such as cement, bricks, and steel. The intervention on the reuse of components in construction triggers similar reductions in the demand for these materials. A difference between the two housing-related interventions is that the reduced demand for construction by end consumers also results in direct GHG-reductions via avoided fuel consumption for heating and energy (17% of the intervention's GHG-reduction), which is not the case for the intervention on the reuse of components. Related to this on the policy side, ESPR<sup>12</sup> mandates durability/reparability for construction products (steel/aluminium prioritized), enabling lifetime extension; CEAP<sup>13</sup> reinforces reuse via recycled content, modular designs, and higher C&D waste recovery under Renovation Wave<sup>14</sup>.

The highest reduction potential for **particulate matter** stems from extending product's lifetime in housing (-11.3 thousand disease inc. or -7.0% relative to the baseline), reduced average floorspace (-7.7 thousand disease inc.; -4.7%), reuse of components in construction (-5.2 thousand disease inc.; -3.2%), ride sharing (-5.0 thousand disease inc.; -3.1%), and reduced car dependency (-4.3 thousand disease inc.; -2.6%).

For PM, the interventions with high impact reduction potential are largely the same as those for the GHG indicator, with the same patterns of reduction in (final) demand driving the effects. A noticeable difference, however, is that an even greater share of the effect is caused by the reduction in direct emissions by end consumers during the use phase (increase from 17% to 40% for extending the useful service life of buildings, and from about 68% to about 75% for the mobility-related interventions).

The reduction potential of the housing-related intervention on reducing the average floor space per person is also strongly linked to reduced direct emissions during the use phase (87% of the total effect) via avoided fuel consumption for heating and energy. For the intervention on increased reuse of components in the construction sector, the reductions in total demand for cement, bricks, and steel are driving the PM-reduction potential, as was the case with the GHG emissions indicator.

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<sup>9</sup> [https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy\\_en](https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en)

<sup>10</sup> [Directive - EU - 2025/1892 - EN - EUR-Lex](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789)

<sup>11</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789>

<sup>12</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746>

<sup>13</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0098>

<sup>14</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662>

The reduction potential for **land-use related biodiversity loss** stems from mainly from promoting a less resource intensive food system ( $-0.54 (10^{-3})$  global pdf or  $-10.3\%$  relative to the baseline), minimising food waste ( $-0.14 (10^{-3})$  global pdf;  $-2.8\%$ ), improved waste management and recycling ( $-0.12 (10^{-3})$  global pdf;  $-2.2\%$ ), increased repair and maintenance of textiles ( $-0.06 (10^{-3})$  global pdf;  $-1.1\%$ ), and extending the useful service life of buildings ( $-0.04 (10^{-3})$  global pdf;  $-0.9\%$ ).

The food-related interventions both reduce demand for output of nearly all agricultural sectors. The intervention on promoting a less resource intensive food system has a significantly larger reduction potential for biodiversity impacts than the other interventions. It strongly reduces demand for animal farming and triggers a reduction in demand for the cultivation of feed grains, along with smaller demand reductions in other agricultural sectors. There is a slight increase in demand for the cultivation of vegetables, fruits, and nuts, but overall, the reduced demand for agricultural activities and their associated effects on land use and land use change is what drives the biodiversity benefits of this intervention.

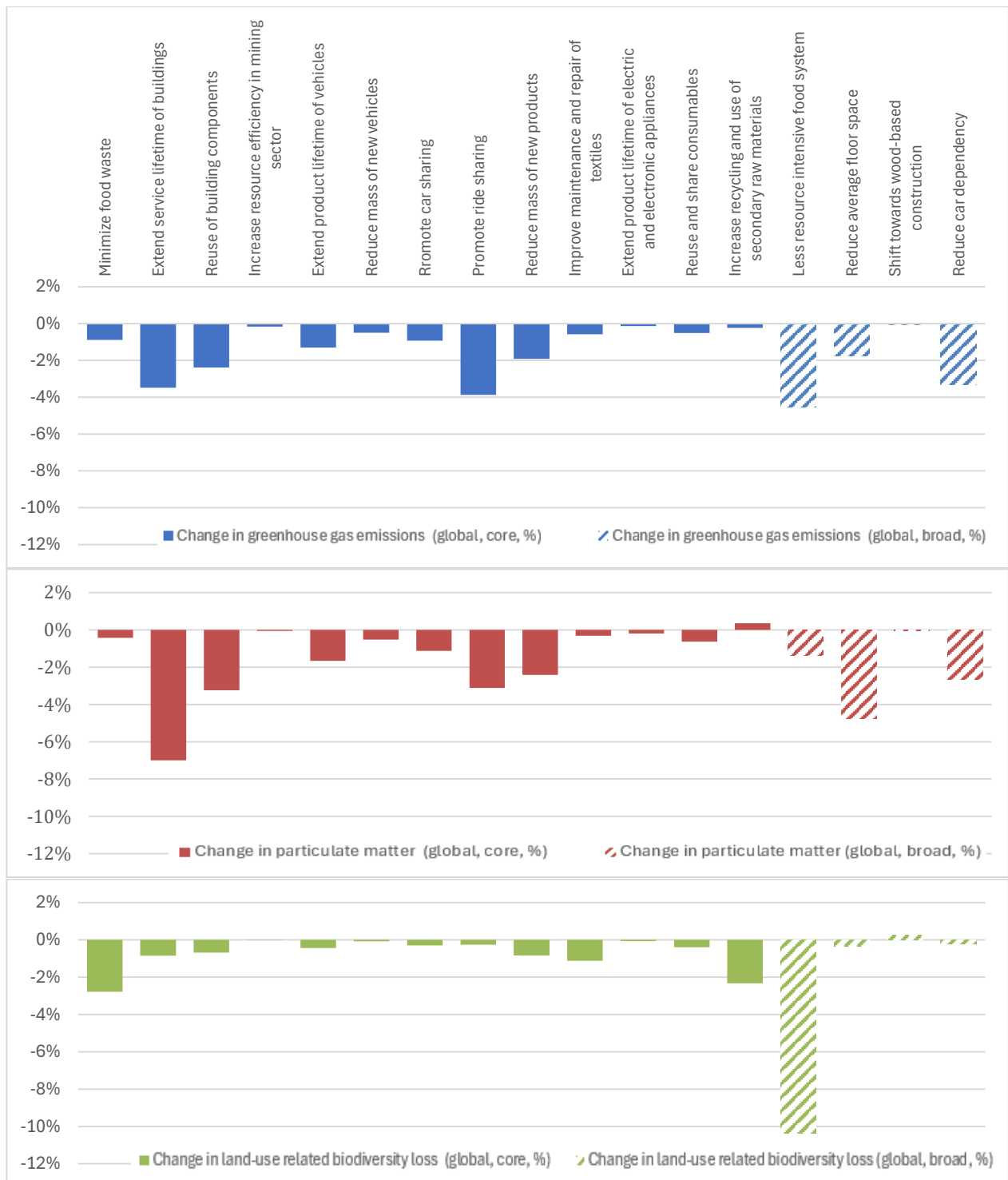
The intervention on the reduction of food waste triggers similar effects, though with a smaller overall biodiversity impact and more evenly distributed across agricultural sectors (largest reductions in demand for raw milk; cultivation of vegetables, fruits, and nuts; and cultivation of cereal grains).

The intervention on improved waste management and recycling impacts triggers effects across the value chain that result in decreased demand for several land-intensive non-agricultural activities, such as the quarrying of stone, sand and clay and other mining activities, and related manufacturing activities such as the manufacture of bricks, glass, ceramics, and other non-metallic mineral products. There is also a notable decrease in demand for the manufacture of wood products and articles of straw and plaiting materials, with associated decreases in forestry and logging and some agricultural activities.

The intervention on increasing repair and maintenance of textiles is associated with reductions in final demand for textiles, wearing apparel, and leather products, which triggers decreases in demand for several land-intensive agricultural activities along the value chain, namely the cultivation of plant-based fibres, production of wool and silk, and to a lesser extent animal products not related to meat production.

Finally, the intervention on extending the useful service life of buildings is associated with decreased demand for construction activities, which triggers decreases in demand for building materials such as cement, bricks, and ceramics, as well as associated mining activities (quarrying of stone, sand, and clay).

**Figure 7-10: Reduction in the climate change (blue), particulate matter (red), and biodiversity (green) footprint of EU-27 consumption individual core and broad interventions (all at high ambition level) in the current economic structure.**



Source: ETC-CE, own calculations.

Note: Footprint approach for climate change (greenhouse gas emissions, in million tons CO<sub>2</sub>-eq.), air pollution (particulate matter, in thousand disease inc.), and biodiversity (land-use related biodiversity loss, in (10<sup>-3</sup>) global pdf). The modelling of each individual intervention in the current economic structure should be interpreted as a what-if scenario in which the intervention is fully implemented (based on the high ambition level). The percentage change compared to the baseline scenario (current economy) is presented on the Y-axis.

### 7.3 Validation of results

Validating the results of circular economy (CE) modelling exercises is inherently challenging. Reported impact reductions across CE studies differ widely, reflecting not only differences in modelling approaches and data sources, but also differences in the scope of CE interventions considered, the level of ambition assumed, the system boundaries applied, and the indicators assessed. Studies vary in whether they focus on selected materials or sectors or adopt an economy-wide perspective, whether they assess individual measures or comprehensive transformation pathways, and whether they model technical potential or more conservative, policy-feasible scenarios. As a result, direct numerical comparison of results should be interpreted with caution, and validation is best understood as a qualitative consistency check rather than a strict benchmarking exercise.

Against this background, the results of this study were compared with a number of prominent CE modelling studies to assess whether the order of magnitude, relative importance of intervention types, and sectoral patterns are broadly consistent with existing evidence.

A first point of comparison is Donati et al. (2020b), who assessed the environmental impacts of 37 specialised circular economy interventions using an environmentally extended input–output framework. While their intervention set is more granular than the 17 more aggregated interventions assessed in this report, the overall reduction potential for climate change impacts reported by Donati et al. is substantially lower, at a maximum of around 10.1%, compared to the approximately 22% reduction estimated here. This difference is largely explained by differences in ambition levels, aggregation of measures, and the combination of interventions in scenario design. Importantly, however, both studies identify delayed replacement and product lifetime extension as among the most influential CE strategies. This is consistent with the findings of this report, which show that interventions acting before use and during use, including lifetime extension of products and components, deliver some of the highest impact reductions across indicators.

A second comparison can be made with the Material Economics (forthcoming) study, which also focuses on the EU context but adopts a more material-specific perspective, concentrating primarily on steel, plastics, aluminium and cement. While that study estimates a reduction potential of around 296 million tonnes of CO<sub>2</sub>-equivalent, this report identifies a substantially larger reduction potential of close to 1 billion tonnes of CO<sub>2</sub>-equivalent. The difference reflects both the broader economy-wide scope of this analysis covering all material categories and provisioning systems and the inclusion of a wider range of circular strategies beyond heavy industry, such as interventions in mobility, housing use, and consumer goods.

A further reference point is the study ‘Completing the Picture’ by the Ellen MacArthur Foundation (EMF, 2021), which assesses the global mitigation potential of circular economy strategies across five key systems: cement, plastics, steel, aluminium and food. That study finds that CE measures could reduce global greenhouse gas emissions by around 40%, whereas the combined interventions assessed in this report lead to an estimated reduction of around 20% for EU-27 consumption. Differences are also visible at the system level: for example, the built environment shows reductions of around 38% in the Completing the Picture study compared to around 20% in this report; the mobility system around 70% compared to around 44%; and the food system around 49% compared to around 23%. These discrepancies are primarily driven by differences in geographical scale (global versus EU-27), intervention ambition, and assumed structural changes, as well as by the more transformational nature of some of the pathways assessed by the Ellen MacArthur Foundation.

Finally, comparison with the results from the EU staff working document “Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society” (EC, 2024) shows partial consistency at the level of individual measures. For example, the reduction potential associated with sustainable food consumption is estimated at around 0.19 million tonnes of CO<sub>2</sub>-

equivalent in that assessment, compared to around 0.6 million tonnes of CO<sub>2</sub>-equivalent in this report. While other measures are difficult to compare directly due to differences in definitions, baselines and modelling approaches, the relative magnitude of impacts and the direction of effects are broadly aligned.

Overall, this comparison suggests that while quantitative estimates vary substantially across studies, the main qualitative conclusions are robust. There is consistent evidence that interventions addressing material use before and during the use phase — such as product lifetime extension, reduced demand for new products, and changes in consumption patterns — have a high potential to reduce environmental impacts. The results of this report therefore fall within the range of existing CE modelling evidence and provide complementary, economy-wide insights that are well suited to inform policy discussion and impact assessment, while acknowledging the inherent uncertainties and scope-dependence of such modelling exercises.

## 8 Conclusions

The modelling results demonstrate the strong environmental potential of circular economy (CE) strategies to reduce the EU-27's consumption footprint across climate change, air pollution, and biodiversity loss – consistent with findings from studies found in the literature. By quantifying impact reductions under different scopes and ambition levels, the analysis highlights where EU-policy can prioritise high-impact CE actions, especially those focused on demand reduction, product lifetime extension, and use-phase efficiency, alongside core loop-closing measures like reuse, repair, and high-quality recycling.

The results emphasize the need to move beyond waste management towards demand-side and design-focused approaches, aligned with the Green Deal, 8th Environment Action Programme, ESPR and upcoming Circular Economy Act. Adopting a consumption-based perspective is crucial, as one-third to half of the potential benefits occur outside of the EU, underlining the importance of global value-chain accountability and trade policy integration.

The key results of this study are summarised below:

- **CE modelling results strongly depend on scope and ambition.**  
Estimated environmental benefits vary widely across studies, primarily due to differences in which circular economy interventions are included, how broadly the circular economy is defined, and the ambition levels assumed. Transparent scoping is therefore essential for interpreting and comparing modelling results.
- **CE interventions can substantially reduce the environmental footprint of EU-27 consumption.**  
When combining core and broader circular economy interventions at high ambition levels, the EU-27 consumption footprint could be reduced by around 22% for climate change, 25% for air pollution, and 19% for land-use-related biodiversity loss.
- **CE interventions also have potential to improve the EU's security of supply.**  
For example, the EU's reliance on extraction of aluminium, nickel, and platinum group metals ores in other world regions could be reduced by around 20%, and for copper by around 12%.
- **Interventions acting before and during product use deliver the largest impact reductions.**  
Measures such as reducing demand for new products, extending the lifetime of products and components, implementing sharing systems, and improving product design consistently show greater environmental benefits than end-of-life measures alone. This is largely due to the substantial environmental impacts associated with the production phase of products; consequently, reducing the demand for new products offers significant potential for impact reduction. This offers economic opportunities for the development of innovative circular business models by shifting the economic importance from resource extraction to the use phase of products, especially in the buildings, transport and food systems.
- **Demand-side interventions add substantial additional benefits.**  
Interventions that directly slow and close material loops (e.g. reuse, repair, lifetime extension, high-quality recycling) account for a substantial share of impact reductions, while broader measures — including demand-side changes and material substitution — provide important additional benefits, particularly for biodiversity.
- **A significant share of environmental benefits occurs outside the EU-27.**  
Between one-third and nearly half of the reductions in climate change, pollution and biodiversity impacts take place outside EU borders, underlining the importance of a consumption-based footprint perspective for assessing circular economy policies.

- **Achieving high ambition levels matters.**  
Medium ambition implementation delivers only around half of the reduction potential achieved under high ambition scenarios, indicating that incremental changes are unlikely to realise the full environmental benefits of the circular economy.
- **Results are broadly consistent with existing CE modelling literature.**  
While absolute reduction potentials differ across studies, this report confirms robust qualitative findings from previous work: delaying product replacement, extending lifetimes, and reducing material demand are among the most effective circular strategies.
- **Modelling results should be interpreted as indicative, not predictive.**  
Due to methodological limitations and uncertainties, the results are best understood as order-of-magnitude estimates that support comparison between interventions and help identify priority areas for policy and impact assessment.
- **The analysis provides actionable input for policy design and impact assessments.**  
By applying a consistent modelling framework across interventions and scopes, the report helps policymakers identify where circular economy strategies can deliver the greatest environmental benefits and how different types of measures interact across sectors and provisioning systems.

While this report documents the work done in 2025, further developments will be done in 2026 to improve the modelling framework and assessment. Circular economy is a policy agenda that has the potential to deliver not only environmental and climate benefits, but also to contribute to a more prosperous, competitive and secure Europe. To understand better the potential of CE interventions on Europe's competitiveness, the existing modelling framework will be further elaborated to estimate the benefits on job creation, GVA and import dependence. This work will focus on a selected number of circular economy interventions, with varying levels of ambition.

## 9 References

- Adeyemi, S. O., et al., 2025, 'From Single-Sensor Constraints to Multisensor Integration: Advancing Sustainable Complex Ore Sorting', *Minerals* 15(11), p. 1101 (DOI: 10.3390/min15111101).
- Aguilar-Hernandez, G. A., et al., 2018, 'Assessing circularity interventions: a review of EEIOA-based studies', *Journal of Economic Structures* 7(1), p. 14 (DOI: 10.1186/s40008-018-0113-3).
- Andreasi, B. S., et al., 2023, *Updated characterisation and normalisation factors for the Environmental Footprint 3.1 method*,.
- Beylot, A., et al., 2019, 'Assessing the environmental impacts of EU consumption at macro-scale', *Journal of Cleaner Production* 216, pp. 382-393 (DOI: 10.1016/j.jclepro.2019.01.134).
- Bocken et al., 2016, 'Product design and business model strategies for a circular economy', *Journal of Industrial and Production Engineering* 33(5), pp. 308-320.
- Cabernard, L., et al., 2024, Resolved Exiobase version 3 (REX3), (<https://zenodo.org/records/10354283>) accessed 13 March 2026, Zenodo.
- Cazcarro, I., et al., 2025, 'FIGARO-E3: a high-resolution extended multi-regional input-output database consistent with official statistics', *Scientific Data* 12(1), p. 575 (DOI: 10.1038/s41597-025-04431-z).
- Chaudhary, A., et al., 2015, 'Quantifying Land Use Impacts on Biodiversity: Combining Species–Area Models and Vulnerability Indicators', *Environmental Science & Technology* 49(16), pp. 9987-9995 (DOI: 10.1021/acs.est.5b02507).
- Cherry, C., et al., 2018, 'Public acceptance of resource-efficiency strategies to mitigate climate change', *Nature Climate Change* 8(11), pp. 1007-1012 (DOI: 10.1038/s41558-018-0298-3).
- Circle Economy, 2023, *The circularity gap report 2023: Methods (v 1.0)*, Circle Economy, Amsterdam (<https://www.circularity-gap.world/methodology>) accessed 25 January 2025.
- Creutzig, F., et al., 2024, 'Demand-side strategies key for mitigating material impacts of energy transitions', *Nature Climate Change* 14(6), pp. 561-572 (DOI: 10.1038/s41558-024-02016-z).
- Donati, F., et al., 2020a, 'Modeling the circular economy in environmentally extended input-output tables: Methods, software and case study', *Resources, Conservation and Recycling* 152, p. 104508 (DOI: 10.1016/j.resconrec.2019.104508).
- Donati, F., et al., 2020b, 'Modeling the circular economy in environmentally extended input-output tables: Methods, software and case study', *Resources, Conservation and Recycling* 152, p. 104508 (DOI: 10.1016/j.resconrec.2019.104508).
- EC, 2024, *Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society {COM(2024) 63 final}*, No SWD/2024/63 final (<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52024SC0063>) accessed 13 March 2026.
- EEA, 2024, 'Accelerating the circular economy in Europe' (<https://www.eea.europa.eu/en/analysis/publications/accelerating-the-circular-economy>) accessed 19 September 2025.

EMF, 2021, *Completing the picture: How the circular economy tackles climate change*, Ellen MacArthur Foundation (<https://www.ellenmacarthurfoundation.org/completing-the-picture>) accessed 13 March 2026.

Eurostat, 2019, 'EU inter-country supply, use and input-output tables — Full international and global accounts for research in input-output analysis (FIGARO)',.

Food Standards Scotland, 2025, 'Modelling the impact of reduction in meat and dairy consumption on nutrient intakes and greenhouse gas emissions in children and young people living in Scotland | Food Standards Scotland' (<https://www.foodstandards.gov.scot/document-web-version/modelling-the-impact-of-reduction-in-meat-and-dairy-consumption-on-nutrient-intakes-and-greenhouse-gas-emissions-in-children-and-young-people-living-in-scotland>) accessed 16 December 2025.

Günther, J., et al., 2026, *Climate mitigation contributions from circular economy actions*, No ETC CE Report 2026/1, European Topic Centre Circular Economy and Resource Use (ETC CE) (<https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2026-1-climate-mitigation-contributions-from-circular-economy-actions>) accessed 1 March 2026.

Haas, W. and Vienna, B., 2024, 'Circular Economy and Decarbonisation: Synergies and Trade-offs',.

Kirchherr, J., et al., 2017, 'Conceptualizing the circular economy: An analysis of 114 definitions', *Resources, Conservation and Recycling* 127, pp. 221-232 (DOI: 10.1016/j.resconrec.2017.09.005).

Kirchherr, J., et al., 2023, 'Conceptualizing the Circular Economy (Revisited): An Analysis of 221 Definitions', *Resources, Conservation and Recycling* 194, p. 107001 (DOI: 10.1016/j.resconrec.2023.107001).

Material Economics, 'Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry' (<https://materialeconomics.com/node/13>) accessed 17 December 2025.

Milios, L., et al., 2025, 'Environmental and socio-economic impacts of the Circular Economy transition in the EU plastics sector', JRC Publications Repository (<https://publications.jrc.ec.europa.eu/repository/handle/JRC143075>) accessed 16 December 2025.

Moraga, G., et al., 2019, 'Circular economy indicators: What do they measure?', *Resources, Conservation and Recycling* 146, pp. 452-461 (DOI: 10.1016/j.resconrec.2019.03.045).

Murray, A., et al., 2017, 'The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context', *Journal of Business Ethics* 140(3), pp. 369-380 (DOI: 10.1007/s10551-015-2693-2).

Nakamoto, Y., et al., 2019, 'The role of vehicle lifetime extensions of countries on global CO2 emissions', *Journal of Cleaner Production* 207, pp. 1040-1046 (DOI: 10.1016/j.jclepro.2018.10.054).

Pauliuk, S., et al., 2021, 'Global scenarios of resource and emission savings from material efficiency in residential buildings and cars', *Nature Communications* 12(1), p. 5097 (DOI: 10.1038/s41467-021-25300-4).

Rommens, T., et al., 2024, *Circular economy and climate change mitigation - analysis and guidance on including Circular Economy actions in climate reporting and policy making*, No ETC CE Report 2024/1, European Topic Centre Circular Economy and Resource Use (ETC CE) (<https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-1-circular-economy-and-climate-change-mitigation-analysis-and-guidance-on-including-circular-economy-actions-in-climate-reporting-and-policy-making>) accessed 21 May 2025.

Scott, K., et al., 2019, 'Bridging the climate mitigation gap with economy-wide material productivity', *Journal of Industrial Ecology* 23(4), pp. 918-931 (DOI: 10.1111/jiec.12831).

Stadler, K., et al., 2025, 'EXIOBASE 3' (<https://zenodo.org/records/15689391>) accessed 16 December 2025.

Tuladhar, S., et al., 2016, 'An Economic Analysis of The Circular Economy', (19th Annual Conference on Global Economic Analysis "Analytical Foundations for Cooperation in a Multipolar World,").

UN, 2024, 'Global Resources Outlook 2024 | UNEP - UN Environment Programme' (<https://www.unep.org/resources/Global-Resource-Outlook-2024>) accessed 9 December 2025.

UNECE, 2023, *Conference of European Statisticians: Guidelines for Measuring Circular Economy, Part A: Conceptual Framework, Indicators and Measurement Framework*, United Nations, Geneva (<https://unece.org/statistics/publications/guidelines-measuring-circular-economy-part-conceptual-framework-indicators>) accessed 17 April 2025.

van Keeken, M., et al., 2024, 'The effects of product lifetime extension on short- and long-term supply chain circularity: A case study of the European aluminum automotive supply chain', *Resources, Conservation and Recycling* 211, p. 107836 (DOI: 10.1016/j.resconrec.2024.107836).

Vercalsteren, A., et al., 2025, *Measuring environmental benefits of Circular Economy*, No ETC CE Report 2025/3 (<https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2025-3-measuring-environmental-benefits-of-circular-economy>) accessed 16 December 2025.

Vita, G., et al., 2019, 'The Environmental Impact of Green Consumption and Sufficiency Lifestyles Scenarios in Europe: Connecting Local Sustainability Visions to Global Consequences', *Ecological Economics* 164, p. 106322 (DOI: 10.1016/j.ecolecon.2019.05.002).

Wagner, A., et al., 2025, *Environmental and socio-economic impacts of the circular economy transition in the EU steel sector: analysing steel material flows with life cycle based and macroeconomic assessment models*, Publications Office of the European Union (<https://data.europa.eu/doi/10.2760/7855491>) accessed 14 November 2025.

Walker, A., et al., 2025, *Capturing the Potential of the Circular Economy Transition in Energy-Intensive Industries*, Publications Office of the European Union, Luxembourg.

Watari, T., et al., 2022, 'Efficient use of cement and concrete to reduce reliance on supply-side technologies for net-zero emissions', *Nature Communications* 13(1), p. 4158 (DOI: 10.1038/s41467-022-31806-2).

Wiebe, K. S., et al., 2018, 'Implementing exogenous scenarios in a global MRIO model for the estimation of future environmental footprints', *Journal of Economic Structures* 7(1), p. 20 (DOI: 10.1186/s40008-018-0118-y).

Wiebe, K. S., et al., 2019, 'Global Circular Economy Scenario in a Multiregional Input–Output Framework', *Environmental Science & Technology* 53(11), pp. 6362-6373 (DOI: 10.1021/acs.est.9b01208).

Wiedenhofer, D., et al., 2025, 'The Circular Economy and Climate Change: The State of National and Global Evidence on Mitigation Potential', *Annual Review of Environment and Resources* (DOI: 10.1146/annurev-environ-111523-102441).

Winans, K., et al., 2017, 'The history and current applications of the circular economy concept', *Renewable and Sustainable Energy Reviews* 68, pp. 825-833 (DOI: 10.1016/j.rser.2016.09.123).

World Economic Forum, 2021, 'Raising Ambitions: A new roadmap for the automotive circular economy', World Economic Forum (<https://www.weforum.org/publications/raising-ambitions-a-new-roadmap-for-the-automotive-circular-economy/>) accessed 16 December 2025.

WWF, 2023, *Circular Economy Model Germany: A Comprehensive Circular Economy*, World Wildlife Fund (WWF), Berlin (<https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Unternehmen/WWF-model-germany-circular-economy.pdf>) accessed 21 May 2025.

## 10 Annex

### 10.1 Factsheets on interventions

Intervention name	Minimize food waste
Description	A circular economy strategy for minimising food waste in production and consumption focuses on keeping food and its biological resources at their highest value for as long as possible. In production (both in agriculture and food processing), this involves improving harvesting, storage, and processing practices so that fewer losses occur before food even reaches the market. By-products such as trimmings, peels, and imperfect produce can be redirected into new food products, animal feed, or ingredient streams rather than being discarded. Surplus food that remains edible is circulated through partnerships between producers, retailers, and redistribution organisations, ensuring that food reaches people instead of becoming waste. On the consumer side, clearer date labels, better packaging, and digital tools for planning and storing food help households use what they buy more effectively.
Core or broad intervention	Core circular economy strategy
Provisioning system	Food
Circular actions	Before use - reduce
Literature review	<p>Waste Framework Directive (WFD):</p> <p>With the 2025 revision, WFD introduces legally binding reduction targets to be achieved by 31 December 2030. Specifically:</p> <ul style="list-style-type: none"> <li>• A 10% reduction (compared to the 2021–2023 average) in food waste from food processing and manufacturing.</li> <li>• A 30% reduction per capita in food waste at the retail and consumption stages combined — that is: retail, restaurants / food services, and households.</li> </ul> <p>Sustainable Development Goals:</p> <p>SDG 12.3 is a global target under Sustainable Development Goals (SDGs) adopted by the UN, under United Nations. Specifically, SDG 12 is about ensuring sustainable consumption and production patterns, and target 12.3 deals with food loss and waste:</p> <ul style="list-style-type: none"> <li>• By 2030, halve per capita global food waste at retail and consumer levels.</li> <li>• Also reduce food losses along production and supply chains — including post-harvest losses.</li> </ul>
Ambition level	<p>High ambition level: -40% of waste in food processing and manufacturing and -50% of food waste by households, retail and restaurants</p> <p>Medium ambition level: -10% of waste in food processing and manufacturing AND -30% of food waste by households, retail and restaurants</p>
Modelling approach	<p>- Reduction in the non-service inputs (it is the input of goods) into the EU-27 agricultural sectors (A01_A-Q), the food industries (C10_A-J), hotels and restaurants (I), and retail (G45, G46, G47_A-B, H49_A-C, H50_A-B, H51, H52, H53) (reducing sectoral inputs) and a reduction in final demand for food products (A01_A-Q, A03, C10_A-J, C11).</p> <p>- For each sector/final demand category it is estimated what share of the output is food waste. This estimation is based on the Eurostat data (env_wasfw). The ambition levels are used to calculate a reduction factor. This factor is used to reduce the total input of each selected sector.</p>

	<p>- Also, for all selected sectors the emission intensities are reduced by the same reduction factor (i.e., to account for a reduction in emissions linked to a reduced input of energy inputs).</p> <p>- The result of this modelling is a new system that compared to the current system produces less food (as final demand is slightly reduced) and produces food more efficient (as less food waste originates throughout the supply network). Note that only changes are applied to the EU-27 production system. Food products or intermediates from outside the EU-27 are unaffected.</p>
<p><b>Results</b> (based on the high ambition level value and modelled using the current economic structure)</p>	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.9%, or 37 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 26 million tons CO<sub>2</sub>-eq. in the EU27  -3.6% (EU-27 footprint of provisioning system on food only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -0.4%, or 0.7 thousand disease inc. (total EU-27 footprint)  of which 0.5 thousand disease inc. in the EU27  -3.6% (EU-27 footprint of the provisioning system on food only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -2.8%, or 0.14 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.09 (10<sup>-3</sup>) global pdf in the EU27  -4.1% (EU-27 footprint of the provisioning system on food only)</p>

Intervention name	Extend service lifetime of buildings
Description	A circular economy strategy to extend the product lifetime of buildings focuses on maximising the useful service life of existing structures through adaptive reuse, flexible design, and higher utilisation. This includes converting underused non-residential buildings (such as offices or retail spaces) into housing, co-working, or community functions, and increasing occupancy rates through shared-use models and time-based leasing. Designing and retrofitting buildings for durability, modularity, and easy maintenance enables components to be repaired, upgraded, or replaced without full demolition, while using reversible connections and standardised elements supports future adaptation. Together, these approaches keep buildings and their materials in productive use for longer, reducing demand for new construction and raw materials.
Core or broad intervention	Core circular economy strategy
Provisioning system	Housing
Circular actions	During use - retain
Literature review	<p>Donati et al. (2020b):  The approach represents longer product or asset lifetimes as a reduced replacement rate of capital stocks, which lowers demand for new construction materials and decreases waste generation. In their framework, lifetime extension scenarios are implemented by adjusting stock turnover rates and final demand for construction sectors, allowing the model to capture economy-wide impacts on resource extraction, energy use and emissions. A 35% lifetime extension is modelled.</p> <p>Walker et al. (2025):  In Walker et al. (2025) lifetime extension of buildings is modelled using a dynamic building-stock and material-flow approach. The report represents the building stock as cohorts by age and type, with demolition probabilities derived from empirical lifetime distributions. Lifetime extension is introduced by shifting demolition curves to the right (i.e., increasing average service life)</p>

	and by adding scenarios for renovation, refurbishment and adaptive reuse, which delay demolition while maintaining functional service. These changes are translated into reduced inflows of new construction materials and delayed outflows of demolition waste, and the effects are then linked to upstream material production (e.g. steel and cement) and associated emissions. They used a +15% lifetime assumption for non-residential buildings and +20% for residential buildings.
Ambition level	High ambition level: +35% lifetime extension of all buildings (i.e., equalling a reduction in demand of 26% for construction) Medium ambition level: +15% lifetime extension of non-residential buildings and +20% lifetime extension for residential buildings (i.e., equalling a reduction in 13% and 17% for construction).
Modelling approach	- The demand for construction (F_A) is reduced by a reduction factor. Both demand from industries and final demand categories are affected. Changes are only applied to EU-27 sector and final demand by EU-27. By changing final demand as a whole, both the demand for products produced in the EU-27 and imported products are reduced. - To account for increased material demand in the construction process an 5% increase in construction demand (F_A) by construction (F_A) is modelled. - The result is a new system that, compared to the current system, has a substantial reduction in the demand for construction. Both demand by industries and final demand (including investments) are reduced substantially. The EU-27 product 'construction' itself is more material intensive (+5%).
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<b>Climate change</b> (greenhouse gas emissions) footprint: -3.5%, or 146 million tons CO <sub>2</sub> -eq. (total EU-27 footprint) of which 107 million tons CO <sub>2</sub> -eq. in the EU27 -9.3% (EU-27 footprint of provisioning system on housing only) <b>Air pollution</b> (particulate matter) footprint: -7.0%, or 11.3 thousand disease inc. (total EU-27 footprint) of which 7.6 thousand disease inc. in the EU27 -11.9% (EU-27 footprint of the provisioning system on housing only) <b>Biodiversity</b> (land-use related biodiversity loss) footprint: -0.9%, or 0.04 (10 <sup>-3</sup> ) global pdf (total EU-27 footprint) of which 0.02 (10 <sup>-3</sup> ) global pdf in the EU27 -8.6% (EU-27 footprint of the provisioning system on housing only)

Intervention name	Reuse of building components (e.g., steel, aluminium and concrete)
Description	A circular economy strategy based on the reuse of building components focuses on preserving the value of structural and non-structural elements by recovering them from existing buildings and reintegrating them into new or renovated projects. Instead of demolishing and downcycling materials, components such as steel beams, façade elements, doors, windows, and modular interior systems are carefully dismantled, inspected, refurbished if needed, and reused. This strategy relies on design for disassembly, standardisation, and material traceability to enable safe and efficient recovery, while reducing demand for virgin materials, lowering embodied carbon, and minimising construction and demolition waste.
Core or broad intervention	Core circular economy strategy
Provisioning system	Housing
Circular actions	During use - reuse and share

Literature review	<p>Literature-based circular scenarios often assume a 15–30% lifetime extension when steel components are designed for disassembly and direct reuse. This is usually modelled as a second service life of about 20–40 years after an initial service life of 50–80 years.</p> <p>Because of brittleness and demolition damage, studies usually assume smaller lifetime extensions for concrete products. Typical modelling assumptions are a 10–20% effective lifetime extension.</p> <p>Sources: Watari et al. (2022), Walker et al. (2025), Pauliuk et al. (2021)</p>
Ambition level	<p>High ambition level: Extending the lifetime of steel, aluminium, and concrete building components resulting in a reduced demand for new materials of 17%, 15%, and 19%, respectively.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- The demand for steel (C24_A-B, C25), aluminium (C24_E-F), and concrete (C23_E) by the construction sector in the EU-27 is reduced by a reduction factor. 10% of this reduction is moved to additional expenditures on construction to model increased durability of new construction.</li> <li>- The result is a construction sector providing the same product by using less input materials, as a proxy for reuse of building components.</li> </ul>
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:</p> <ul style="list-style-type: none"> <li>-2.4%, or 101 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 67 million tons CO<sub>2</sub>-eq. in the EU27</li> <li>-6.3% (EU-27 footprint of provisioning system on housing only)</li> </ul> <p><b>Air pollution</b> (particulate matter) footprint:</p> <ul style="list-style-type: none"> <li>-3.2%, or 5.2 thousand disease inc. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 2.1 thousand disease inc. in the EU27</li> <li>-5.2% (EU-27 footprint of the provisioning system on housing only)</li> </ul> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:</p> <ul style="list-style-type: none"> <li>-0.7%, or 0.04 (10<sup>-3</sup>) global pdf (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 0.02 (10<sup>-3</sup>) global pdf in the EU27</li> <li>-6.9% (EU-27 footprint of the provisioning system on housing only)</li> </ul>

Intervention name	Increase resource efficiency in mining sector
Description	<p>A circular economy strategy focused on increased resource efficiency in the mining sector aims to maximise the value obtained from extracted minerals while minimising waste, energy use, and environmental impacts throughout the extraction and processing activities. This can be achieved, for example, by improving ore-sorting and beneficiation technologies to recover more valuable material from lower-grade ores, reducing losses in crushing and grinding, and optimising water and energy use in mineral processing. The strategy also encompasses reprocessing of mine tailings and waste rock to recover residual metals, cascading the use of materials within the industrial system, and extending the productive life of mines through better geological modelling and selective extraction, thereby reducing the need for inputs to these activities.</p>
Core or broad intervention	Core circular economy strategy
Provisioning system	Others
Circular actions	Before use - rethink
Literature review	<p>Scientific literature reports measurable gains from resource-efficiency and circular strategies in mining — typically expressed as higher metal recovery, reduced feed tonnage, or lower energy/use per ton. Improvements in beneficiation and sorting combined with better process control and AI can cut</p>

	<p>downstream energy and water use and reduce grinding/processing volumes — studies and industry reports commonly indicate single-digit to low-double-digit percent reductions in energy per ton or cost per unit metal when such measures are applied.</p> <p>Sources: Adewuyi et al. (2025), Tuladhar et al. (2016)</p>
Ambition level	<p>High ambition level: 10% increase in resource efficiency of mining activities</p> <p>Medium ambition level: 1.4% increase in resource efficiency of mining activities</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduction in inputs of all non-service inputs to all EU-27 mining activities (B05, B06_A-C, B07_A-H, B08_A-C).</li> <li>- A reduction in the emission intensities of EU-27 mining sectors, to reflect the reduction in energy use.</li> <li>- The result is a EU-27 mining industry providing the same output compared to the current system, but using less input materials.</li> </ul>
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint: -0.2%, or 7 million tons CO<sub>2</sub>-eq. (total EU-27 footprint) of which 6 million tons CO<sub>2</sub>-eq. in the EU27</p> <p><b>Air pollution</b> (particulate matter) footprint: -0.1%, or 0.1 thousand disease inc. (total EU-27 footprint) of which 0.1 thousand disease inc. in the EU27</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint: -0.0%, or 0.00 (10<sup>-3</sup>) global pdf (total EU-27 footprint) of which 0.00 (10<sup>-3</sup>) global pdf in the EU27</p>

Intervention name	Extend product lifetime of vehicles
Description	<p>A circular economy strategy focused on increasing the lifetime of vehicles aims to retain vehicles in productive use for longer by slowing replacement rates across cars, trucks, buses, rail vehicles, and other transport equipment. This is achieved through design for durability and repair, modular components, predictive maintenance, and systematic refurbishment or remanufacturing of key systems such as engines, drivetrains, batteries, and interiors. Operational strategies such as fleet maintenance optimisation, shared and secondary markets, and repurposing vehicles for lower-intensity applications further extend useful life. By delaying end-of-life and reducing demand for new vehicle production, this strategy lowers material and energy use, embodied emissions, and waste generation while maintaining transport service levels.</p> <p>Also, the reuse of car components is included in this intervention focusing on extending the functional lifetime of high-value parts by recovering them from end-of-life vehicles and reintroducing them into the vehicle fleet. Components such as engines, transmissions, electric motors, batteries, electronics, and interior modules are removed, tested, refurbished if necessary, and reused either as spare parts or in remanufactured vehicles. This strategy relies on design for disassembly, standardised components, quality assurance systems, and reverse logistics to ensure safety and performance. By retaining the embedded materials, energy, and manufacturing effort in components for longer, reuse reduces demand for new component production, lowers resource use and emissions, and delays waste generation while maintaining vehicle functionality.</p>
Core or broad intervention	Core circular economy strategy
Provisioning system	Mobility
Circular actions	During use - retain

Literature review	<p>A systems-dynamics modelling study of the European automotive supply chain includes explicit lifetime extension scenarios for vehicles: a 10 %, 25 %, and 50 % increase in baseline lifetime (starting from ca. 12 years) is simulated, and the model results show that a 25 % lifetime extension implemented in 2025 reduces the global warming potential (GWP) of the system by 16.7 % by 2050 relative to the business-as-usual scenario, with roughly proportional effects for 10 % and 50 % extensions. (van Keeken et al., 2024)</p> <p>The Global Resource Outlook report (2024) includes vehicle life spans as one of the variables in their modelling. For new vehicles they increase the mean lifetime (in years) in their resource efficiency scenario as an option to reduce material use. They increase the mean lifetime by 10% for airplanes, by 40% of railway equipment, by 33% for ships, by 10% for trucks, by 20% for busses and bicycles, and by 22.5% for cars.</p> <p>Wagner et al. (2025) apply the figures suggested by WTO in a recent report (World Economic Forum, 2021), which suggest that lifetime increase of about 25% at EU level is technically possible. This means an increase in the average lifetime of cars in the EU from current 12.3y to 15.4y, which is comparable to the global average lifetime of 15.8y estimated by Nakamoto et al. (2019). This translates into a reduction in the demand of steel products for cars by 20%.</p>
Ambition level	<p>High ambition level: A lifetime extension of cars by 22.5% resulting in a reduction of material input by 18% and a extension of the lifetime of all other vehicles by 20% resulting in a reduction in material input by 17%. 10% of the reduced expenditures are moved to increased maintenance and repair of vehicles (G45). In addition, the manufacturing of vehicles is reducing their inputs of components by 20%.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduction in the demand for vehicles (C29 and C30) by all industries (-17% for the high ambition level).</li> <li>- A reduction in the demand for vehicles (C29 and C30) by all final demand categories (-18% for the high ambition level).</li> </ul> <p>A reduction in the demand for components (C16_A, C22, C23_A, C24_A-B, C24_C-N, C25, C26_A-B, C27, C28_A, C28_B, C29, and C30) by the manufacturing of vehicles (C29 and C30).</p> <ul style="list-style-type: none"> <li>- As a result, the demand for new vehicles and vehicle components is reduced, with a slight increase in demand for maintenance and repair activities.</li> </ul>
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:</p> <ul style="list-style-type: none"> <li>-1.3%, or 55 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 30 million tons CO<sub>2</sub>-eq. in the EU27</li> <li>-6% (EU-27 footprint of provisioning system on mobility only)</li> </ul> <p><b>Air pollution</b> (particulate matter) footprint:</p> <ul style="list-style-type: none"> <li>-1.7%, or 2.7 thousand disease inc. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 1.0 thousand disease inc. in the EU27</li> <li>-9.3% (EU-27 footprint of the provisioning system on mobility only)</li> </ul> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:</p> <ul style="list-style-type: none"> <li>-0.4%, or 0.02 (10<sup>-3</sup>) global pdf (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 0.01 (10<sup>-3</sup>) global pdf in the EU27</li> <li>-9.1% (EU-27 footprint of the provisioning system on mobility only)</li> </ul>

Intervention name	Reduce mass of new vehicles
Description	A circular economy strategy focused on mass reduction for newly sold vehicles aims to reduce material use and associated impacts by lowering the weight of vehicles across all transport modes, including passenger cars, trucks, buses, and other road and non-road vehicles. This is achieved through lightweight

	design, material substitution, functional integration, and improved structural efficiency, such as using high-strength steels, aluminium, or advanced composites to deliver the same performance with less material. By reducing the mass of vehicles placed on the market, this strategy lowers demand for primary raw materials and decreases embodied impacts from manufacturing, while often also improving energy efficiency during the use phase, thereby reducing total life cycle impacts per vehicle-kilometre.
Core or broad intervention	Core circular economy strategy
Provisioning system	Mobility
Circular actions	Before use - reduce
Literature review	<p>Scientific literature models vehicle mass reduction primarily as a change in material intensity per new vehicle entering the stock. In these models, mass reduction is usually parameterised as a percentage reduction in curb weight of newly sold vehicles (e.g. 10–20%) relative to a baseline, while keeping vehicle utility constant.</p> <p>The vehicle lightweighting is a strategy applied in the Global Resource Outlook report (2024) focussing on newly sold vehicles. The overall weight reduction of 18% is applied (considering a 47% market penetration rate) of new motorized road-vehicles. This corresponds with a weight reduction of 8.4% for cars, busses and trucks and 4.2% for airplanes, railway equipment, ships, and bicycles.</p> <p>Pauliuk et al. (2021) also include product light-weighting through better design/downsizing or material substitution as global scenario in their paper on resource and emission savings from material efficiency in residential buildings and cars. The modelling includes an increase in the share of microcars and passenger cars.</p>
Ambition level	<p>High ambition level: Using the values from the Global Resource Outlook report (2024), which are a mass reduction of 8.4% for cars, busses and trucks and 4.2% for airplanes, railway equipment, ships, and bicycles.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduction in the material input (C16_A, C22, C23_A, C24_A-B, C24_C-N, C25, C26_A-B, C27, C28_A, C28_B, C29, and C30) of producing cars (C29, -8.4%) and other vehicles (C30, -4.2%).</li> <li>- Accompanying the lightweighting of vehicles is a reduction in fuel consumption (C192) modelled for final demand. This reduction is equal to 50% of the mass reduction for cars.</li> <li>- Accompanying the reduction in fuel consumption is a reduction in the direct emissions by households. The direct emission intensity coefficient of households is reduced by 50% of the change in fuel consumption.</li> <li>- As a result, this intervention gives a reduction in material input to vehicle manufacturing and a reduced fuel consumption.</li> </ul>
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.5%, or 21 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 17 million tons CO<sub>2</sub>-eq. in the EU27  -2.6% (EU-27 footprint of provisioning system on mobility only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -0.5%, or 0.8 thousand disease inc. (total EU-27 footprint)  of which 0.6 thousand disease inc. in the EU27  -3.4% (EU-27 footprint of the provisioning system on mobility only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -0.1%, or 0.00 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.00 (10<sup>-3</sup>) global pdf in the EU27</p>

	-1.7% (EU-27 footprint of the provisioning system on mobility only)
Intervention name	Promote car sharing
Description	A circular economy strategy based on sharing systems for cars and other vehicles focuses on increasing the utilisation rate of vehicles by enabling multiple users to access the same asset instead of owning under-used private vehicles. Car-sharing, shared vans, bikes, and micro-mobility fleets allow a smaller number of vehicles to deliver the same or greater mobility services through digital platforms, coordinated scheduling, and professional fleet management. By intensifying use, sharing systems reduce the total number of vehicles needed, lower material demand for vehicle production, and improve resource efficiency, while centralised maintenance and refurbishment can further extend vehicle lifetimes and support circular use of components.
Core or broad intervention	Core circular economy strategy
Provisioning system	Mobility
Circular actions	Before use - rethink
Literature review	<p>Scientific literature typically models vehicle sharing systems as a reduction in vehicle ownership and new vehicle sales, combined with higher utilisation rates and faster turnover of shared fleets. Quantitative assumptions commonly range from 1 shared car replacing 5 to 15 private cars, depending on context (urban density, service type). At fleet level, this is translated into scenarios where new vehicle sales are reduced by 5–20% relative to baseline. The Global Resource Outlook report (2024) includes a 20% increase in mileage for passenger cars and 10% for other vehicles, similar to a reduction in new vehicles sold of 17% and 9%, respectively.</p> <p>Other sources mention:</p> <ul style="list-style-type: none"> <li>- Pauliuk et al. (2021) model a car-sharing service demand from 15 to 30%.</li> <li>- In Haas et al. (2024) a drastic reduction in car ownership by 86% car ownership (car sharing is partly providing access to car mobility) is modelled.</li> </ul>
Ambition level	<p>High ambition level: A reduction in newly sold cars by 17%, and a reduction in other vehicles by 9%.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduction in newly sold cars (C29) by all industries and final demand categories.</li> <li>- A reduction in newly sold vehicles (C30) by all industries and final demand categories.</li> <li>- 10% of the reduction is moved to increased expenditures on maintenance and repair (G45).</li> <li>- As a result, the amount of newly sold vehicles is reduced to reflect a reduction in the size of the car parc. The intensified use of vehicles is covered by increased maintenance and repair.</li> </ul>
Results (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.9%, or 39 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 23 million tons CO<sub>2</sub>-eq. in the EU27  -4.5% (EU-27 footprint of provisioning system on mobility only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -1.1%, or 1.8 thousand disease inc. (total EU-27 footprint)  of which 0.8 thousand disease inc. in the EU27  -6.7% (EU-27 footprint of the provisioning system on mobility only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -0.0%, or 0.02 (10<sup>-3</sup>) global pdf (total EU-27 footprint)</p>

	of which 0.00 (10 <sup>-3</sup> ) global pdf in the EU27 -6.4% (EU-27 footprint of the provisioning system on mobility only)
Intervention name	Promote ride sharing
Description	A circular economy strategy based on ride-sharing systems for personal transport focuses on increasing the occupancy of vehicles by enabling multiple passengers to share the same trip, thereby delivering the same mobility service with fewer vehicle-kilometres and vehicles. Digital platforms and real-time matching allow travellers with similar routes and schedules to pool rides in private cars, taxis, or shared fleets, improving seat utilisation and reducing empty or under-used trips. By increasing average occupancy rates, ride sharing lowers fuel and energy use per passenger-kilometre, reduces emissions and congestion, and can slow growth in vehicle ownership and production, contributing to more resource-efficient mobility systems.
Core or broad intervention	Core circular economy strategy
Provisioning system	Mobility
Circular actions	Before use - refuse
Literature review	Scientific literature typically models ride sharing (carpooling and pooled ride-hailing) as an increase in vehicle occupancy that reduces vehicle-kilometres travelled per passenger-kilometre. In transport demand and fleet stock models, ride sharing is implemented by increasing average occupancy rates (e.g. from 1.2–1.5 persons per car to 1.6–2.0), which translates into vehicle-kilometres reductions of about 5–20% for the same level of passenger mobility. These reductions are then propagated to lower fuel (or electricity) consumption, typically resulting in 5–15% reductions in fuel use at system level, depending on uptake and rebound effects. Pauliuk et al. (2021) model a 40% increase in the occupancy rate. A 40% increase is similar to a 29% reduction in vehicle demand.
Ambition level	High ambition level: A reduction in newly sold cars by 29%, based on a 40% increase in the occupancy rate. Medium ambition level: Half of the high ambition level values.
Modelling approach	- A reduction in the newly sold vehicles (C29 and C30) to final demand. - A reduction in the fuel consumption (C192) by final demand. - Accompanying the reduction in fuel consumption is a reduction in the direct emissions by households. The direct emission intensity coefficient of households is reduced by the change in fuel consumption. - As a result, the increased occupancy rate gives a reduction in newly sold vehicles and fuel consumption.
Results (based on the high ambition level value and modelled using the current economic structure)	<b>Climate change</b> (greenhouse gas emissions) footprint: -3.9%, or 163 million tons CO <sub>2</sub> -eq. (total EU-27 footprint) of which 129 million tons CO <sub>2</sub> -eq. in the EU27 -20% (EU-27 footprint of provisioning system on mobility only) <b>Air pollution</b> (particulate matter) footprint: -3.1%, or 5.0 thousand disease inc. (total EU-27 footprint) of which 4.1 thousand disease inc. in the EU27 -20.8% (EU-27 footprint of the provisioning system on mobility only) <b>Biodiversity</b> (land-use related biodiversity loss) footprint: -0.3%, or 0.01 (10 <sup>-3</sup> ) global pdf (total EU-27 footprint) of which 0.00 (10 <sup>-3</sup> ) global pdf in the EU27 -5.8% (EU-27 footprint of the provisioning system on mobility only)

Intervention name	Reduce mass of new products (packaging, electronics, consumables)
Description	A circular economy strategy focused on reducing the use and weight of packaging materials and consumables aims to lower material demand at the design and production stage for consumer goods such as textiles, electronics, personal care products, and household items. This strategy involves lightweighting and eliminating unnecessary packaging, shifting to minimal or concentrated product formats, reducing material intensity of products through design optimisation, and substituting single-use components with durable or refillable solutions. By delivering the same function with less material, this approach reduces demand for virgin resources, lowers manufacturing and transport impacts, and decreases waste generation across product life cycles.
Core or broad intervention	Core circular economy strategy
Provisioning system	Goods and consumables
Circular actions	Before use - reduce
Literature review	<p>Scientific literature models reductions in packaging and consumable material use primarily through material-flow approaches, where the mass of packaging or consumables per unit of product is treated as a key parameter. In these models, a 10–30% reduction in material intensity per product is commonly implemented as a scenario variable, representing lightweighting, elimination of over-packaging, or concentrated product formats. Examples are:</p> <ul style="list-style-type: none"> <li>- Under the Packaging and Packaging Waste Regulation, quantified reduction targets for packaging waste are established: compared with 2018 levels, packaging waste per capita must be reduced by 5 % by 2030, 10 % by 2035, and 15 % by 2040. These targets explicitly address the use of materials by limiting packaging excess and improving design for sustainability.</li> <li>- Reduced weight of packaging materials (metal, plastics, paper, glass: -30%), lightweighting of steel in electronics and appliance (-27%), remanufacturing electronics and computers (-15%), reduce the weight of steel in furniture (-27%). (Scott et al., 2019) (Cherry et al., 2018)</li> <li>- Reduction of the absolute amount of primary plastic used in products (-25%). This is achieved by the reduction of plastic content in products, or by the substitution of plastics with other materials, without compromising their functionality. (Milios et al., 2025)</li> </ul>
Ambition level	<p>High ambition level: A 30% reduction in packaging materials (with a 25% market share for plastics, 3% for steel, 25% for aluminium, 60% for glass and 85% for paper/cardboard) and a 30% reduction for other goods and consumables.</p> <p>Medium ambition level: 15% reduction.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduction in demand is modelled for plastic packaging (C20_C), steel packaging (C24_A-B), aluminium packaging (C24_E), glass packaging (C23_A) and paper/cardboard and other packaging (C17_B, C22, C23_A, C25) by all industries.</li> <li>- A reduction in demand for input materials (C20_C, C24_A-B, C24_N, C24_E, C23_A, C17_B, C22, C23_A, C25) by producers of goods and consumables (C25, C26_A, C26_B, C27, C28_A, C28_B, C31_32).</li> <li>- As a result, the use of packaging materials is reduced and the use of input materials for a selection of sector is reduced. The selection of sectors is based on the link to the goods and consumables manufacturing (excluding food, housing and mobility).</li> </ul>
Results (based on the high ambition level)	<p><b>Climate change</b> (greenhouse gas emissions) footprint: -1.9%, or 81 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)</p>

value and modelled using the current economic structure)	<p>of which 41 million tons CO<sub>2</sub>-eq. in the EU27</p> <p>-4.3% (EU-27 footprint of provisioning system on other good and consumables only)</p> <p><b>Air pollution</b> (particulate matter) footprint:</p> <p>-2.4%, or 3.9 thousand disease inc. (total EU-27 footprint)</p> <p>of which 1.4 thousand disease inc. in the EU27</p> <p>-5.9% (EU-27 footprint of the provisioning system on other good and consumables only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:</p> <p>-0.8%, or 0.04 (10<sup>-3</sup>) global pdf (total EU-27 footprint)</p> <p>of which 0.02 (10<sup>-3</sup>) global pdf in the EU27</p> <p>-2.0% (EU-27 footprint of the provisioning system on other good and consumables only)</p>
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Intervention name	Improve maintenance and repair of textiles
Description	A circular economy strategy focused on increasing maintenance and repair of textiles aims to extend the useful life of clothing, home textiles, and technical fabrics by keeping products in use longer. This includes repairing damage, reinforcing worn areas, cleaning and restoring materials, and upgrading or altering items to meet changing functional or fashion needs. By maintaining textile quality and functionality, this strategy reduces the frequency of replacement purchases, lowers demand for virgin fibers and raw materials, decreases manufacturing energy and emissions, and reduces textile waste. It relies on accessible repair services, design for durability and modularity, and consumer awareness to ensure that textiles remain in circulation for as long as possible.
Core or broad intervention	Core circular economy strategy
Provisioning system	Goods and consumables
Circular actions	During use - retain/repair
Literature review	Scientific literature on maintenance and repair of textiles models this strategy to quantify how extending product lifetimes affects resource use and environmental impacts. In these models, repair and maintenance are typically implemented as a lifetime extension factor for garments or textiles: for example, scenarios assume that effective repair and care increase the average service life by 20–50%, which reduces the inflow of newly sold textiles by 10–20% compared with a business-as-usual scenario. (Scott et al., 2019)
Ambition level	High ambition level: 27.6% reduction in demand for new textiles due to improved maintenance and repair, based on Scott et al. (2019) using a 30% reduction and a market penetration rate of 92%. Medium ambition level: Half of the high ambition level value.
Modelling approach	- A reduction of inputs by all sectors from the textiles manufacturing sectors (C13, C14, C15). - A reduction of inputs of textile products (C13, C14, C15) by household final demand. - As a result, the demand for textile products by industries and households is reduced.
Results (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:</p> <p>-0.6%, or 24 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)</p> <p>of which 5 million tons CO<sub>2</sub>-eq. in the EU27</p> <p>-3.2% (EU-27 footprint of provisioning system on other good and consumables only)</p>

	<p><b>Air pollution</b> (particulate matter) footprint:  -0.3%, or 0.5 thousand disease inc. (total EU-27 footprint)  of which 0.1 thousand disease inc. in the EU27  -1.8% (EU-27 footprint of the provisioning system on other good and consumables only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -1.1%, or 0.06 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.01 (10<sup>-3</sup>) global pdf in the EU27  -8.2% (EU-27 footprint of the provisioning system on other good and consumables only)</p>
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Intervention name	Extend product lifetime of electric and electronic appliances (EEE)
Description	A circular economy strategy focused on extending the product lifetime of electric and electronic appliances aims to keep devices such as computers, smartphones, household appliances, and industrial electronics in use for longer periods. This is achieved through durable design, modular components, repair and refurbishment services, software updates, and upgradeable parts that allow products to maintain functionality over time. By delaying replacement, the strategy reduces demand for new devices, lowers raw material extraction and manufacturing impacts, and decreases electronic waste generation. Effective implementation relies on accessible repair networks, standardized components, and consumer awareness to maximize the operational life of appliances while maintaining safety and performance standards.
Core or broad intervention	Core circular economy strategy
Provisioning system	Goods and consumables
Circular actions	During use - retain
Literature review	Scientific literature on extending the product lifetime of EEE models this strategy to quantify impacts on resource use, energy demand, and emissions. In these models, lifetime extension is implemented as a change in the average service life of appliances, often expressed as a percentage increase in product lifetime or as a reduction in replacement rates. For example, a scenario may assume a 20% increase in appliance lifetime, which translates into a 10–15% reduction in newly sold EEE compared with a business-as-usual scenario. Wagner et al. (2025): extend lifetime of mechanical equipment by 17% through design for durability and repairability.
Ambition level	High ambition level: Modelling a reduced demand of 15% (based on lifetime extension of 17%) for new EEE. Medium ambition level: Half of the high ambition level values.
Modelling approach	- A reduced demand for EEE (C26_A, C26_B, C27, C28_A, C28_B) by households.
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.1%, or 6 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 2 million tons CO<sub>2</sub>-eq. in the EU27  -0.8% (EU-27 footprint of provisioning system on other good and consumables only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -0.2%, or 0.3 thousand disease inc. (total EU-27 footprint)  of which 0.1 thousand disease inc. in the EU27  -1.2% (EU-27 footprint of the provisioning system on other good and consumables only)</p>

	<p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -0.1%, or 0.00 10<sup>8</sup> global pdf (total EU-27 footprint)  of which 0.00 10<sup>8</sup> global pdf in the EU27  -0.5% (EU-27 footprint of the provisioning system on other good and consumables only)</p>
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Intervention name	Reuse and share consumables
Description	A circular economy strategy based on the reuse and sharing of consumables aims to reduce material demand and waste by enabling multiple users to access the same products or components, rather than relying on single ownership or single-use consumption. Reuse is promoted through refillable or returnable systems, while sharing is facilitated by platforms, cooperatives, or rental services that coordinate access among multiple users. By keeping consumables in circulation longer and maximising their utilisation, this strategy decreases the need for new production, lowers raw material extraction and manufacturing impacts, and reduces waste generation across product life cycles.
Core or broad intervention	Core circular economy strategy
Provisioning system	Goods and consumables
Circular actions	During use - reuse and share
Literature review	<p>Scientific literature on reuse and sharing of consumables typically models this circular economy strategy focusing on how increased utilisation or multiple use-cycles affect production and waste flows. In these models, sharing or reuse is implemented by reducing inflow rates of new products into the stock, corresponding to the portion of demand met by shared or reused items. For example, in studies of office furniture or tools, a scenario might assume that sharing and reuse allow fewer new units to be sold, while maintaining the same level of service or functional output.</p> <p>An example is found mentioning a reduction in new furniture by 27% via increased sharing and reuse and 33% for leisure equipment. (Scott et al., 2019)</p>
Ambition level	<p>High ambition level: Modelling a reduced demand of 33% for new goods and consumables (non-textiles, non-EEE).</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	- A reduced demand for other goods and consumables (C22, C25, C31_32) by households.
Results (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.5%, or 22 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 8 million tons CO<sub>2</sub>-eq. in the EU27  -2.3% (EU-27 footprint of provisioning system on other good and consumables only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -0.6%, or 1.0 thousand disease inc. (total EU-27 footprint)  of which 0.4 thousand disease inc. in the EU27  -2.6% (EU-27 footprint of the provisioning system on other good and consumables only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -0.4%, or 0.02 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.01 (10<sup>-3</sup>) global pdf in the EU27  -2.9% (EU-27 footprint of the provisioning system on other good and consumables only)</p>

Intervention name	Increase recycling and use of secondary raw materials
Description	A circular economy strategy focused on recycling aims to recover materials from end-of-life products, waste streams, or by-products and reintroduce them into production processes as secondary raw materials. This reduces the need for virgin material extraction, conserves resources, lowers energy use and greenhouse gas emissions associated with primary production, and decreases waste sent to landfills or incineration. Recycling strategies encompass mechanical and chemical recycling, sorting and separation technologies, and closed-loop systems that maintain material quality for reuse in the same or alternative applications. By transforming waste into valuable inputs, recycling closes material loops, supports resource efficiency, and contributes to a more sustainable, circular industrial system.
Core or broad intervention	Core circular economy strategy
Provisioning system	Goods and consumables
Circular actions	After use - recycle/return
Literature review	The modelling is based on Vercauteren et al. (2025), see Section 4.3 and Table 4-1.
Ambition level	High ambition level: As a result of improved collection and recycling, secondary raw materials can substitute for primary raw materials lowering the demand of chemicals (-2.7%), rubber and plastics (-6.4%), wood (-13.3%), textiles (-3.9%), EEE (-0.6%), food (-7.4%), and non-metallic minerals (-15.0%). Medium ambition level: Half of the high ambition level values.
Modelling approach	- A reduction in the demand for primary materials is modelled for chemicals (C20_A-B, C21), rubber and plastics (C20_C, C22), wood (C16_A), textiles (C13, C14, C15), EEE (C26_A-B, C27, C28_A-B), food (C10_A-J, C11), and non-metallic minerals (B08_A-C, C23A, C23_C-D, C23_G). - The reduction is substituted for the demand for secondary materials: C20_D for chemicals and rubber and plastics, C16_B for wood, E37T39 for textiles, EEE, food, and non-metallic minerals.
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<b>Climate change</b> (greenhouse gas emissions) footprint: -0.2%, or -10 million tons CO <sub>2</sub> -eq. (total EU-27 footprint) of which -7 million tons CO <sub>2</sub> -eq. in the EU27 <b>Air pollution</b> (particulate matter) footprint: +0.4%, or 0.6 thousand disease inc. (total EU-27 footprint) of which 0.0 thousand disease inc. in the EU27 <b>Biodiversity</b> (land-use related biodiversity loss) footprint: -2.3%, or 0.12 (10 <sup>-3</sup> ) global pdf (total EU-27 footprint) of which 0.08 (10 <sup>-3</sup> ) global pdf in the EU27

Intervention name	Less resource intensive food system
Description	A circular economy strategy focused on promoting a less resource intensive food system aims to lower resource use and environmental impacts by shifting dietary patterns from animal-based foods toward plant-based alternatives while maintaining overall caloric intake and nutritional adequacy. This strategy reduces demand for resource-intensive livestock production and reallocates consumption toward non-animal food categories such as grains, legumes, vegetables, and plant-based protein products, which generally require less land, water, and energy per calorie. By maintaining caloric intake while changing the composition of diets, the approach improves the efficiency with which biological resources are converted into food for human consumption,

	reduces waste and emissions along the food system, and supports more resilient and sustainable food supply chains.
Core or broad intervention	Broad circular economy strategy
Provisioning system	Food
Circular actions	Before use - refuse
Literature review	<p>Scientific literature on the circular-economy strategy of reducing meat consumption typically models it as a dietary demand-shift scenario. These models define scenarios where meat and other animal products are substituted with nutritionally equivalent plant-based foods or lower-impact alternatives and then compute changes relative to a baseline diet.</p> <p>Vita et al. (2019) uses an environmentally extended multi-regional input-output (EE-MRIO) model to quantify the impacts of broad lifestyle changes, including dietary and consumption shifts, on environmental footprints across Europe. Within the suite of scenarios, a shift toward vegan/plant-based diets was included under food strategies. In the Mediterranean diet they decrease non-fish meat products consumption by 80%.</p> <p>In a recent research report from Food Standards Scotland population average meat and dairy consumption declines by 20% by 2035, rising to a 35% reduction in meat by 2050 compared to 2019 levels. (Food Standards Scotland, 2025)</p>
Ambition level	<p>High ambition level: -80% change in the consumption of meat by household final demand, redistributed across other food consumption based on caloric intake. The caloric values per euro expenditure from different food categories are based on Vita et al. (2019).</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	- The modelling of meat consumption is focussing on demand by households and demand by restaurant (I). Both reduce the demand for animal products (A01_I-M, C10_A-D), and substitute this for non-animal food products (A01_A-E, A01_H, C10_E-J). The substitution factor is based on caloric intake values. The weight of each product in total food consumption is fixed and is based on the weight in non-animal food products before changes.
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -4.5%, or 190 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 143 million tons CO<sub>2</sub>-eq. in the EU27  -19.2% (EU-27 footprint of provisioning system on food only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -1.4%, or 2.2 thousand disease inc. (total EU-27 footprint)  of which 1.8 thousand disease inc. in the EU27  -12.1% (EU-27 footprint of the provisioning system on food only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -10.3%, or 0.54 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.34 (10<sup>-3</sup>) global pdf in the EU27  -14.6% (EU-27 footprint of the provisioning system on food only)</p>

Intervention name	Reduce average floor space
Description	A circular economy strategy focused on reducing floor space per capita aims to lower material use and energy demand by delivering the same living and working functions with less built area per person. This can be achieved through more efficient building design, multifunctional spaces, shared facilities, co-housing and co-working arrangements, and improved occupancy of existing buildings. By decreasing the amount of floor space required per

	capita, this strategy reduces demand for new construction materials, limits land take, and lowers operational energy use for heating, cooling, and maintenance, thereby extending the usefulness of existing building stocks and improving overall resource efficiency in the built environment.
Core or broad intervention	Broad circular economy strategy
Provisioning system	Housing
Circular actions	Before use - reduce
Literature review	Scientific literature models a reduction in floor space per capita, where floor area is a key driver of construction demand and operational energy use. The strategy is implemented by lowering the assumed average residential or non-residential floor area per person relative to a baseline, while keeping population and service levels constant. Quantitative scenario assumptions commonly range from 5–20% reductions in floor space per capita by a given target year, reflecting denser living, shared spaces, or higher occupancy rates. The Global Resource Outlook report (2024) uses a reduction in residential floorspace per capita in 2060 from 49.3 m <sup>2</sup> (baseline) to 30.7 m <sup>2</sup> (resource efficiency scenario) in Europe. For commercial floorspace the reduction is 21.8m <sup>2</sup> to 15.3m <sup>2</sup> .
Ambition level	High ambition level: -25% change in the average floorspace per capita. Medium ambition level: Half of the high ambition level values.
Modelling approach	<ul style="list-style-type: none"> <li>- The input to the construction sector (F_A) is reduced for a selection of building materials (B07_A-H, B08_A-C, C16_A, C22, C23_C, C23_E, C23_G, C23_A-B, C24_C, C24_E, C24_G, C24_I, C24_K, C25).</li> <li>- A reduction in the direct emissions by households is added to reflect for the decreased need for heating. The direct emission intensity coefficient of households is reduced by 50% of the reduced demand for construction.</li> <li>- As a result, the demand for construction is maintained, but the building process is less material demanding.</li> </ul>
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -1.8%, or 74 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 64 million tons CO<sub>2</sub>-eq. in the EU27  -4.9% (EU-27 footprint of provisioning system on housing only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -4.7%, or 7.7 thousand disease inc. (total EU-27 footprint)  of which 7.0 thousand disease inc. in the EU27  -8.6% (EU-27 footprint of the provisioning system on housing only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  -0.3%, or 0.02 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.01 (10<sup>-3</sup>) global pdf in the EU27  -3.4% (EU-27 footprint of the provisioning system on housing only)</p>

Intervention name	Shift towards wood-based construction
Description	A circular economy strategy focused on shifting to wood-based construction aims to replace emissions- and resource-intensive materials such as concrete and steel with sustainably sourced timber products in buildings and infrastructure. Engineered wood solutions, including cross-laminated timber and glulam, enable wood to be used in multi-storey and non-residential construction while maintaining structural performance and safety. By increasing the share of renewable, bio-based materials, this strategy reduces embodied greenhouse gas emissions, supports carbon storage in the built environment, and can lower overall material impacts when wood is sourced

	from sustainably managed forests and designed for long service lives and end-of-life recovery.
Core or broad intervention	Broad circular economy strategy
Provisioning system	Housing
Circular actions	Before use - rethink
Literature review	<p>Scientific literature models a shift to wood-based construction. In this modelling, the strategy is implemented by changing the material composition per square metre of floor area, for example substituting a defined share of reinforced concrete and steel with engineered wood products. Quantitatively, scenarios often assume 10–50% substitution of concrete and steel in new residential and non-residential buildings, depending on building type and height.</p> <p>The Global Resource Outlook report (2024) uses a 20% material substitution in all new housing (wood-construction). Steel use is reduced by 93%, concrete use by 60% and the use of wood increased by 260%.</p>
Ambition level	<p>High ambition level: 20% substitution of mineral building materials by wood-based building materials.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	- The use of building materials C23_C-E, C23_G, C23_A-B, C24_C, C24_E, C24_G, C24_I, C24_K, C25 by the construction sector (F_A) is substituted by wood products (C16_A).
<b>Results</b> (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:  -0.1%, or 2.4 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)  of which 2.0 million tons CO<sub>2</sub>-eq. in the EU27  -0.2% (EU-27 footprint of provisioning system on housing only)</p> <p><b>Air pollution</b> (particulate matter) footprint:  -0.0%, or 0.1 thousand disease inc. (total EU-27 footprint)  of which 0.0 thousand disease inc. in the EU27  -0.1% (EU-27 footprint of the provisioning system on housing only)</p> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:  +0.2%, or 0.01 (10<sup>-3</sup>) global pdf (total EU-27 footprint)  of which 0.01 (10<sup>-3</sup>) global pdf in the EU27  +2.1% (EU-27 footprint of the provisioning system on housing only)</p>

Intervention name	Reduce car dependency
Description	A circular economy strategy focused on reducing household car dependency aims to lower material and energy use by decreasing the need for private vehicle ownership while still meeting mobility needs. This is achieved through improved access to public transport, active travel infrastructure, shared mobility services, compact urban design, and digital alternatives that reduce travel demand. By shifting mobility provision from privately owned, under-utilised cars to more efficient collective and non-motorised modes, the strategy reduces demand for vehicle production, fuel consumption, and related infrastructure, while increasing the utilisation efficiency of existing transport assets and supporting more resource-efficient mobility systems.
Core or broad intervention	Broad circular economy strategy
Provisioning system	Mobility
Circular actions	Before use - refuse
Literature review	Scientific literature that models a reduced household car dependency, the strategy is implemented by lowering car ownership rates per household or

	<p>reducing car travel demand (vehicle-kilometres travelled, VKT) while maintaining overall mobility through public transport, active modes, and shared mobility. Quantitatively, scenarios often assume 5–20% reductions in household car ownership in urban and peri-urban areas, which translate into 5–15% reductions in new vehicle sales over time.</p> <p>The Global Resource Outlook report (2024): reduce overall transport demand in person kilometres in line with increased teleworking and alternative tourism (25% reduction in activity).</p>
Ambition level	<p>High ambition level: 25% less vehicles sold to households and 25% reduction in sales of transport fuels by households.</p> <p>Medium ambition level: Half of the high ambition level values.</p>
Modelling approach	<ul style="list-style-type: none"> <li>- A reduced demand for new vehicles (C29) by households.</li> <li>- A reduced demand for transportation fuels (C192) by households.</li> <li>- Accompanying the reduction in fuel consumption is a reduction in the direct emissions by households. The direct emission intensity coefficient of households is reduced by the change in fuel consumption.</li> </ul>
Results (based on the high ambition level value and modelled using the current economic structure)	<p><b>Climate change</b> (greenhouse gas emissions) footprint:</p> <ul style="list-style-type: none"> <li>-3.3%, or 139 million tons CO<sub>2</sub>-eq. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 111 million tons CO<sub>2</sub>-eq. in the EU27</li> <li>-17.4% (EU-27 footprint of provisioning system on mobility only)</li> </ul> <p><b>Air pollution</b> (particulate matter) footprint:</p> <ul style="list-style-type: none"> <li>-2.6%, or 4.3 thousand disease inc. (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 3.5 thousand disease inc. in the EU27</li> <li>-18.0% (EU-27 footprint of the provisioning system on mobility only)</li> </ul> <p><b>Biodiversity</b> (land-use related biodiversity loss) footprint:</p> <ul style="list-style-type: none"> <li>-0.2%, or 0.01 (10<sup>-3</sup>) global pdf (total EU-27 footprint)</li> <li style="padding-left: 20px;">of which 0.00 (10<sup>-3</sup>) global pdf in the EU27</li> <li>-5.0% (EU-27 footprint of the provisioning system on mobility only)</li> </ul>

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