



Consumption Footprint and Domestic Footprint Outlook Report 2025

Projections towards 2030 in the frame of the Zero Pollution Action Plan

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Abstract

The European Commission - Joint Research Centre has developed and kept updating since 2016 a modelling framework that includes the **Consumption Footprint (CF)** and the **Domestic Footprint (CF)** models, which have become established as a means for monitoring the progress of the EU's environmental performance. The models are based on **Life Cycle Assessment, and use the Environmental Footprint (EF) impact assessment method to produce a set of 16 indicators** (also available as a single weighted score) to assess the environmental impacts of EU production and consumption, and compare to the planetary boundaries.

This report describes how these models can be applied to generate an outlook in the framework of the Zero Pollution Action Plan (ZPAP) for 2030. This is performed via: (i) calculating the ZPAP official targets in the context of the models, (ii) integrating selected relevant and illustrative green transition measures from the targets and ambitions of the European Green Deal (iii) comparing three progressively more ambitious scenarios simulating the achievement of these measures.

The results indicate that the gap is widening between the environmental impacts occurring within the EU's borders and those linked to consumption via supply chains, that is, those that result from imports into the EU. The selected green transition measures should make progress in terms of reducing environmental impact within the EU. However, via integrating additional ambitions the EU could accelerate actions for almost all EF environmental indicators, and reduce the EU's environmental impact of consumption even below the ZPAP 2030 targets.

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1 Introduction

Our economies and societies inherently depend on nature and urgent action is needed to address what is known as the **“triple planetary crisis”** in terms of pollution, climate change and biodiversity loss (Hellweg et al., 2023). These crises are interconnected, and addressing them requires tools which are capable of addressing such systemic complexity. Evidence shows that the degree and rate of exploitation of natural resources is unsustainable, for example with respect to the use of land and water resources (UNEP 2021). Resource use is linked to associated **pollution**, which has increasingly damaged habitats, particularly over the past half-century leading to rapid, destabilising changes in the Earth's ecosystems (IRP 2017). The increase of pollution and greenhouse gas (GHG) emissions beyond the planet's capacity to absorb them is leading to **climate change and the climate crisis**, also known as global warming or global heating (IPCC 2023). This is evidenced by observable change in rainfall patterns and the occurrence of droughts worldwide, with significant impacts on societies, environment and the economy. This large-scale and rapid degradation of ecosystems is leading to unsustainable **biodiversity loss**, characterised by a decrease in species (extinctions) decrease of fauna and flora populations per se, and a reduction in intra-species diversity (IPBES 2019, IPCC 2023). This represents one of the main threats to our planet today. From a human-centric perspective it poses a potential crisis in the functioning of established agricultural and food systems as we presently know them (EC 2020a).

The emerging landscape requires a transition towards sustainability, presenting significant challenges to policymaking, particularly in assessing **trade-offs between environmental impacts**, and strategies for their reduction (e.g., Sala et al., 2021). **The development of modelling tools capable of simultaneously addressing the various aspects of the planetary crises is therefore key in providing inputs to effective policy making.** Life Cycle Assessment (LCA) models provide one solution to systematically analyse this systemic and complex net of issues (Hellweg et al., 2023). LCA can be described as *“the quantitative integrated impact assessment methodology used to assess the environmental impacts resulting from resource use as well as emissions to the environment along the entire life cycles of products, processes or systems”* (Sanyé-Mengual and Sala 2022). Via the application of LCA, potential **trade-offs among life cycle stages or environmental impacts can be identified, thereby allowing for the development of mitigation strategies.**

The European Commission - Joint Research Centre (EC-JRC) has since 2016 developed and annually updated an LCA-based modelling framework that includes the **Consumption Footprint (CF)** and the **Domestic Footprint (DF)** models, which have become established as a prominent and recognised means for monitoring progress of EU environmental performance. Both the CF and the DF employ the **Environmental Footprint (EF) life cycle impact assessment (LCIA) method** (EC, 2021a), which is recommended by the European Commission for the **Life Cycle Assessment (LCA)** of products and organisations. The EF method assesses **16 environmental impact categories**, which may be aggregated into a single and normalised weighted score to assess overall progress. The models are employed to assess the environmental impacts of EU production

and consumption, and may be used to compare the resulting footprints against planetary boundaries¹.

In a nutshell, the Consumption Footprint and the Domestic Footprint use different approaches to modelling which are complementary to one another. The **Domestic Footprint (DF)** relies on national and EU official statistics (e.g., ESTAT, UNFCCC) and modelled data regarding resource extraction and emissions to the environment within the EU's boundaries from 2000 up to 2022.

The **Consumption Footprint (CF)** calculates the environmental impacts associated with 164 representative products; some of these "products" comprise the use of a transport mode, e.g., types of car and train travel, as well as more conventional products such as food types or washing machines. The 164 products are grouped into five areas of consumption (food, mobility, housing, household goods and appliances) and are assessed by combining official EU and national statistics on consumption from 2010 to 2022, with a full bottom-up LCA model for these products (Sanyé Mengual and Sala, 2023).

These CF and associated indicators are updated with new data on an annual basis (see Sanyé-Mengual et al. 2025), and are used to monitor progress of EU policies and frameworks, for example: (i) the 8th Environmental Action Programme (EC 2022a), (ii) the Zero Pollution Action Plan (EC 2021b), (iii) the EU Circular Economy monitoring framework (EC 2020a), (iv) the EU Sustainable Development Goals monitoring framework (Eurostat 2024a), (v) the Resilience Dashboard (EC, 2023a), and (vi) the EU Food System Monitoring Dashboard (EC-JRC, 2024a). The use of the CF in EU official monitoring frameworks often includes an absolute sustainability perspective by mean of comparison of the Consumption Footprint against planetary boundaries (EC-JRC 2022).

The EC-JRC has recently implemented adjustments to the CF and the DF models to explore potential policy scenarios, aiming to gain a better understanding of future impacts. The analysis can be considered as an Integrated Environmental Assessment (IEA) exercise as it synthesises a variety of existing consumption and environmental impact data and their associated uncertainties with the purpose of providing guidance for decision makers on the consequences of varying management actions, including inactions (Boileau et al. 2019). This report describes in detail how the CF and the DF models can be employed to generate outlooks of the potential evolution of the environmental impacts of EU production and consumption. This has been performed via scenario analyses with a focus on the Zero Pollution Action Plan (ZPAP) (EC 2021b) and a selection of 50 European Green Deal (EGD) (EC 2019) targets (either legally-binding or not) and ambitions (non-legally binding by nature).

The EGD provides a reference policy framework that includes the Zero Pollution Action Plan (ZPAP), e.g., targets of air quality impact on human health, or pesticide reduction in agriculture, as well as encompassing broader aspects of the sustainability transition (e.g., targets to improve energy efficiency in buildings, or expansion of renewables in the EU energy mix). These range from industrial policies (e.g., the second Circular Economy Action Plan, (EC 2020b), the Chemical Strategy for Sustainability (EC, 2020c)) to sectoral policies linked to food (EC, 2020d), housing renovation (EC, 2020e), or smart mobility and transport (EC, 2020f). By achieving the broader set of selected

¹ The PBs can be assessed with the EF LCIA method¹ through a specific LCA-based PBs set that was developed by the JRC (Sala et al., 2020).

EGD targets and ambitions, namely green transition targets (GTT) and ambitions, the attainment of ZPAP objectives could potentially be facilitated.

This report is an update to the work performed in support of the **Zero Pollution Monitoring Outlook 2022** (EC-JRC 2022), incorporating updated data and performed in light of recent policy insights up to 2024. In particular, this report includes the use of the DF model with a focus on the EU's domestic activities of production and consumption (e.g., industrial production, manufacturing, resource use and resulting emissions). It also presents an expansion of the analysis performed in 2022 (EC-JRC, 2022), with additional modelled targets and scenarios in the CF, and revised definition of ZPAP targets in the CF and DF models. (see EC-JRC, 2025 for a broader review of policy levers supporting EGD)

The scenarios consider the progressively higher levels of environmental ambition associated with the EGD thus giving insights on their attainment (or not), as follows: (i) least ambitious (“No GTT” scenario) - disregarding the effects of green transition policy; (ii) medium ambition (“GTT” scenario) - achieving all green transition legally binding requirements, and the non-legally binding target aiming to reduce by 50% the use of pesticides, and the target of a 55% reduction in health impacts due to air pollution by 2030, owing due to their importance to the pollution targets; and (iii) most ambitious - (“GTT ambitious”) - achieving both legally binding targets as well as green transition ambitions. The “GTT ambitious” scenario includes goals such as shifting towards a sustainable and healthy diet or the renovation wave for buildings in the EU.

As a result, the report delves into the detail of the DF, and all the five product groups (or “consumption areas”) of the CF model (food, housing, mobility, household goods, and appliances). In addition, it zooms in to case studies linked to particularly high level scenarios that are analysed as being able to reduce environmental impacts in the CF model. It is worth noting that the study does not consider elements such as (i) uncertainties linked to the existence of rebound effects or other feedback mechanisms that can influence results (e.g., price change and adaptation due to policy interventions) (see Guzzo et al. 2025), (ii) product specific policies that compose the CF model in the appliances and housing goods sectors. In addition, the limited scope of the selected EGD targets limit the study as a partial assessment of green transition targets and ambitions, in the context of the CF and DF models.

This report is structured as follows. Section 2 illustrates the relevance of LCA for policy, and provides a description of the models used for the analysis, including how these are used in the policy context. Section 3 explains the methodology of the Integrated Environmental Assessment, that is, how the DF and the CF models have been used to represent green transition targets and generate projections up to 2030. Section 4 describes the state of environmental impacts in the year 2022 (i.e., the reference year for the outlook) for both models, and compares them with the planetary boundaries. Section 5 provides the output of the analysis with the DF model (details on the modelling assumptions are included in Annex 2 and Annex 3). Section 6 gives details of the output generated using the CF model, including a glimpse into every basket of products (details are included in Annex 2 and Annex 4), and highlights the trade-offs and opportunities between area of policy interventions with the greatest potential impacts. Section 7 shows where evidence points to high leverage targets for food, mobility and housing. Section 8 provides evidence of the analysis in the context of the Zero Pollution Monitoring Outlook 2024 (EEA-JRC, 2025). Section 9 discusses the limitations of this study, and Section 10 summarises the content and concludes the report.

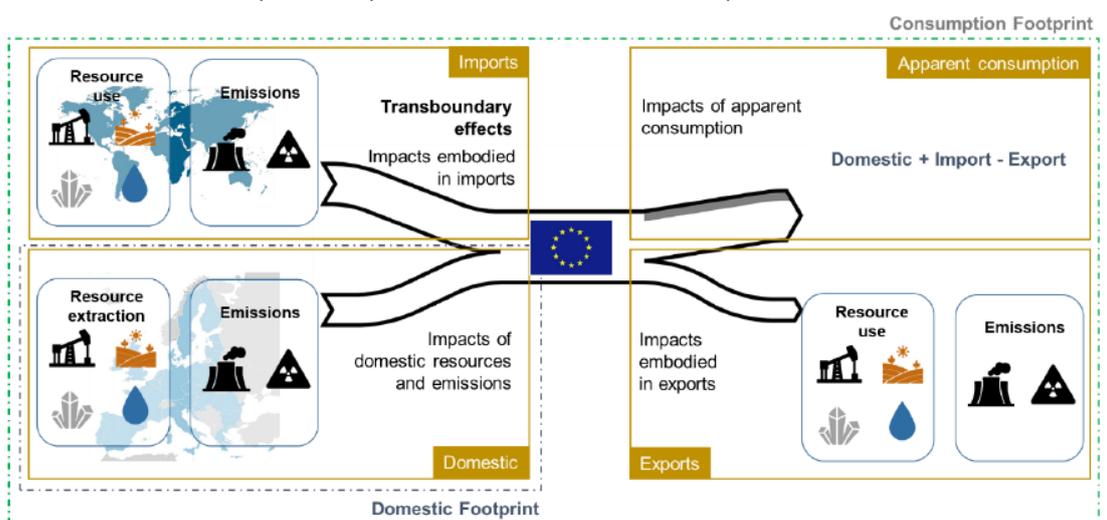
2 The relevance of Consumption Footprint and Domestic Footprint models for EU policy

2.1 The importance of combining a territorial approach (within the EU's borders) and an overall EU consumption approach (including imports)

EU production and consumption of goods and services are core components of economic value, bringing well-being and prosperity to European citizens. They allow EU Member States - via (inter alia) manufacturing, information technology and services activities, as well as via EU citizens' purchasing power - to increase their competitiveness and fund innovation, as part of being a key geo-political actor in the global economy. However, increased domestic production and consumption has an associated greater environmental impact, leading to increased exploitation of natural territorial resources and emissions to the environment, thus leading to degradation of EU air, water and soil quality, and related ecosystems.

On the other hand, in order to satisfy the demand of EU consumers, the EU also needs to import raw materials, intermediary products and final products from third countries. In turn, the EU is a key trade partner for other world regions to satisfy their consumption demands and therefore exports raw materials, intermediary products and final products to third countries. In order to monitor the environmental impact of EU consumption, it is therefore essential to account for the international dimension of trade, where the environmental impact can be tracked to the territorial impact in third countries, eventually with a global scope. The JRC **Domestic Footprint** (DF; Sanyé Mengual et al., 2022) and the **Consumption Footprint** (CF, Sanyé Mengual and Sala, 2023; Sanyé Mengual et al., 2025) (Figure 1) are designed to provide two complementary perspectives on the environmental impact of the EU. The two approaches comprise: (i) a **territorial perspective** focused on emissions and resource extraction occurring within the EU (the DF) and (ii) a **consumption (supply chain) perspective** also taking into account traded products, i.e., both import and export flows, thus accounting for the impact of EU consumption both within the EU and the effects in the supply chain of imported products on third countries (the CF).

Figure 1. The JRC framework to assess the environmental impact of EU consumption footprint, including the Consumption Footprint (CF) and the Domestic Footprint (DF) models.

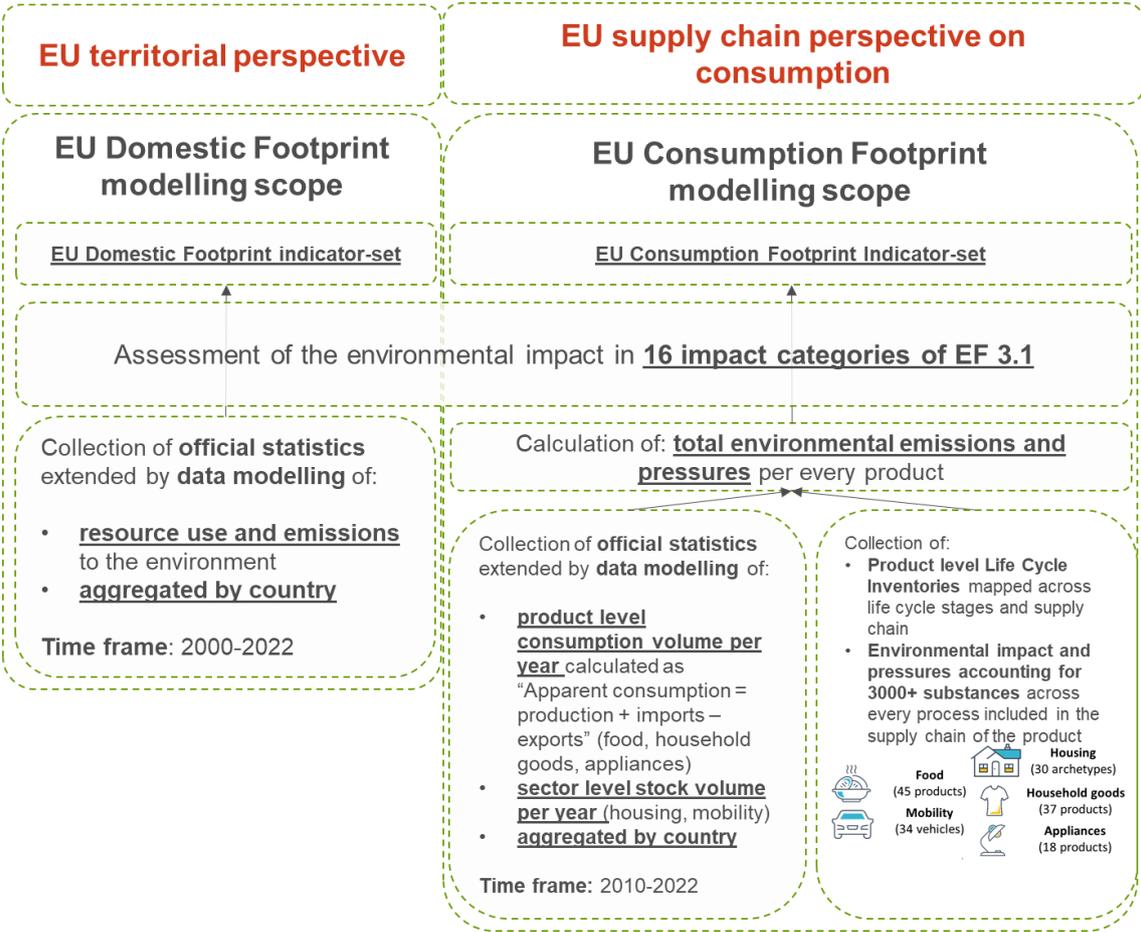


Source: Sanyé Mengual et al., (2023a)

These two models employ the **Environmental Footprint LCIA method (version 3.1)** (EC 2021a), which includes **16 impact categories** used to monitor the evolution of impacts in an integrated manner (addressing simultaneously impacts resulting from resource use and pressures on air, soils and water). The models can be described as follows (see also Figure 2):

- The **EU Domestic Footprint (DF)** is based on publicly available EU statistical information, (e.g. from ESTAT, UNFCCC) complemented with modelled emissions, where there are gaps in the statistics. These data on direct domestic emissions (and extraction and use of resources) are then used as inputs to assess the related environmental impacts, confined within the EU’s territorial boundaries.
- The **EU Consumption Footprint (CF)** makes use of 164 representative products to calculate the environmental impacts associated to five areas of consumption (food, mobility, housing, household goods and appliances). It combines official statistics on consumption (including production and trade) from 2010 to 2022 with a full bottom-up LCA model for the representative products. The EU CF takes into account the impacts due to consumption in the EU with a supply chain perspective. This means that the domestic impacts of the products made within the EU are taken into account together with the imported impacts stemming from products which are imported into the EU, while excluding the impacts of exported products.

Figure 2. EU Domestic Footprint and Consumption Footprint models starting from EU territorial and consumption statistics.

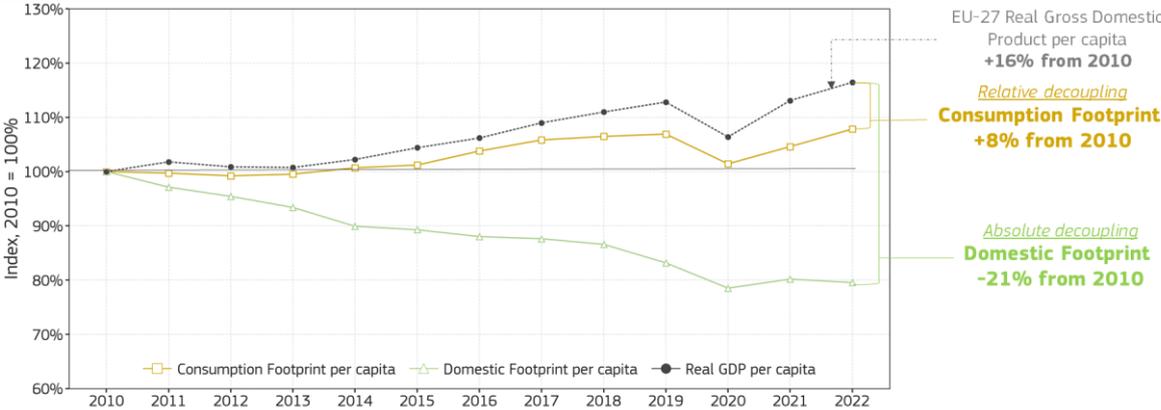


Source: JRC elaboration.

The models allow the collation of a list of environmental pressures, in terms of resource use and emissions to the environment (life cycle inventory). This inventory is then assessed in the life cycle impact assessment stage, where environmental pressures are computed into the integrated environmental assessment employing the **Environmental Footprint 3.1 impact assessment method** (the recommended method for the LCA of products and organisations (EC 2021a)). The LCIA results in estimates of potential impacts among **16 environmental impact categories** (i.e. acidification; climate change; ecotoxicity freshwater; eutrophication freshwater; eutrophication marine; eutrophication terrestrial; human toxicity cancer; human toxicity non cancer; ionizing radiation; land use change; ozone depletion; particulate matter; photochemical ozone depletion; resource use fossil fuels; resource use minerals and metals; water use). The range of impact categories of the EF method enables the identification of potential trade-offs among environmental impacts (e.g., the achievement of a policy target may reduce climate change impacts but may lead to a higher consumption of resources of minerals and metals). The 16 impacts can be aggregated into a single normalised and aggregated score, or compared with the **planetary boundaries approach** (Sala et al., 2020).

The importance of combining a domestic approach (i.e., within the geographical boundaries of the EU’s territory) and a consumption approach (i.e., a global scope, embedding trade flows with third countries) is shown well when analysing the trend of environmental impacts against real economic growth. **Figure 3** shows that, over a period of 12 years, real Gross Domestic Product (**GDP per capita has been continuously growing in real terms (+16%)**) (Eurostat 2024b), whilst over the same period (using the single weighted score) there has been a **decrease of -21% in the EU DF** (Sanyé Mengual et al., 2025).

Figure 3. Evolution of the EU Domestic Footprint and EU Consumption Footprint compared with Gross Domestic Product per capita index (2010=100%), for the period 2010-2022.



Source: Consumption Footprint Platform (EC-JRC 2024b), Eurostat (2024b). The figure shows two areas for the analysis of decoupling: Absolute decoupling– presenting negative trends and demonstrating improvements in environmental performance; Relative decoupling – presenting positive trends but below the rate of GDP, thus worsening environmental performance in absolute terms. GDP data are represented by the variable Chain Linked volumes, Index, 2010=100%

This points to a positive effect of the implementation of EU environmental policy (within the EU’s borders), e.g. through banning or setting targets of pollutants (Sanyé Mengual et al., 2019). Since many of the EU’s environmental policies target the economic or consumption activities within the European Union’s borders, the positive effects of such spatially-related policies are more relevant on EU ‘territorial’ environmental pressures (e.g. resource extraction and emissions to the environment) and associated impacts. One interpretation of the above-noted difference may

indicate that the EU is a front-runner, with higher environmental standards, potentially thus acting as a global example, inspiring similar efforts in other world regions. Another - and parallel - interpretation is that the EU is partly reliant for its prosperity due to imports of intermediate and finished goods, whilst not suffering the environmental pressures associated with the production of these goods from third countries (i.e., we import the products and raw materials, but the associated resource use and pollution instead remain in the country (ies) of their origin) (Sanyé Mengual et al., 2019).

However, the **CF per capita, which also includes the trade component, shows an increasing trend (+8%)** in the same single weighted score index over this period. This is partly due to the fact that the EU imports raw materials, intermediate goods and final products from third countries; and that the amount of imported environmental impacts is higher than the environmental impacts associated with the exported goods to third countries. The associated embedded environmental impacts of these goods, which are consumed in the EU, indicates that **the EU is a net importer of environmental impacts which occur elsewhere, that is, beyond its borders**. This might not be surprising, since the imported share of some products and traded commodities in the EU, such as crude oil and critical raw materials, may even surpass the 90% of total EU consumption (EC 2024a).

When compared against real GDP per capita, the decrease of the DF between 2010 and 2022 shows an absolute decoupling of **environmental impacts from economic growth**, while the increase of the CF suggests only relative decoupling, as its growth rate is lower than economic expansion. This corresponds to a relative increase in the CF in absolute terms from 2010 to 2022 (Sanyé Mengual et al., 2025).

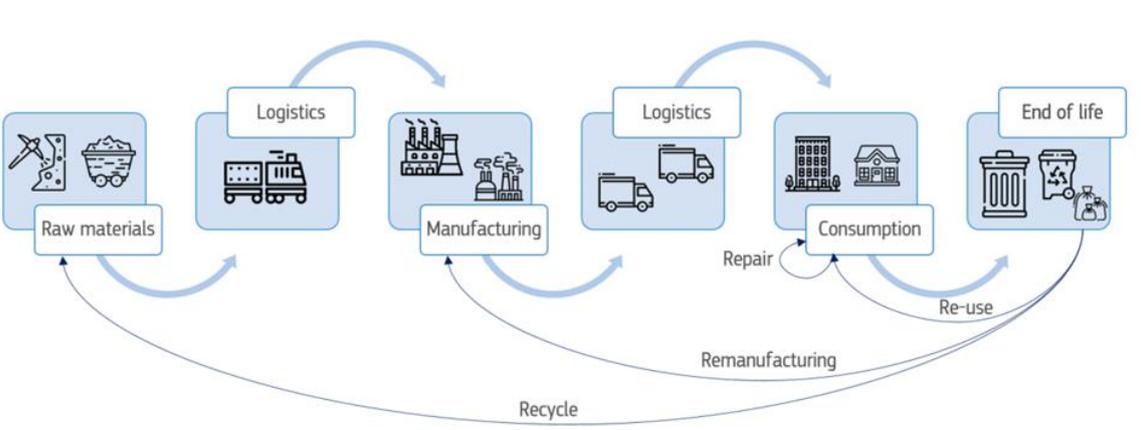
This analysis shows that a consumption-based perspective as well as a territorial production-based one is key to the overall evaluation of the environmental impacts of an economy. The territorial assessment produced by the DF alone could lead to a biased and positive conclusion (absolute decoupling), while the global outlook of the CF shows instead that **the EU is today a net importer of environmental externalities, or impacts**. This indicates that the improvement in reducing the EU DF is being at least partly offset by the **delocalised impacts to other world regions through the reliance on international supply chains**. This results support the increasing policy efforts in recent EU environmental legislation to shift the focus to the EU international market (a consumption-based approach) rather than solely with regard to addressing EU producers (a territorial approach). This trend builds on the existing suite of Ecodesign and Energy Labelling measures, for example, by, e.g., setting product requirements on minimum standards for placing products on the EU market, regardless of the origin of their production origin (e.g. the Ecodesign for Sustainable Products Regulation (EC 2024b), the Regulation on Deforestation-free products (EC, 2023b), or the Carbon Border Adjustment Mechanism (EC, 2023c).

2.2 Policy relevance of a systemic life-cycle approach addressing multi-dimensional trade-offs

The implications of EU consumption patterns may have cascading spill-over effects to third countries via the network of **international supply chains**. In a **cradle to grave** approach, supply chains transform material resources into products, products are in turn used until they wear out or become obsolete; after use materials may be recycled, reused or discarded. Materials, systems, and products have environmental, social and economic impacts outside of their use stage. Impacts usually occur over the entire life cycle of products, systems, services or materials, for example, during the extraction of raw materials, production and manufacturing stages, transportation of the

product, its use phase and finally end of life treatment. One of the key strengths of LCA - in particular for models such as the Consumption Footprint - is to map out the network of relationships throughout the life cycle stages of the products concerned. The result of this mapping is the Life Cycle Inventory (LCI)². Figure 4 shows a generic example of this “cradle to grave” approach across international supply chains, which quantifies the benefits and burdens associated with materials, systems, and products at each of these stages. By monitoring the amount of consumption of a specific good, and multiplying this value with the quantified associated environmental impacts across its entire supply chain, one can calculate the total environmental impacts associated with the good being investigated. As such, an LCA approach provides key evidence as input to informed policy support throughout the policy cycle.

Figure 4. Overview of Life Cycle Stages from Raw materials to End of Life, including alternative End of Life pathways according to Circular Economy strategies.



Source: JRC elaboration.

In this respect, the European Green Deal (EGD) (EC, 2019) emphasises the importance of trade and supply chains with respect to achieving sustainability (inter alia, Sanyé Mengual and Sala, 2022). Such an emphasis on supply chains and consumption, as well as the possibility of addressing this systematically through life cycle thinking (LCT) has gradually been utilised in EU policy-making over the last three decades (Sala et al., 2021). EGD-related policies with a strong supply chain component include the Circular Economy Action Plan (EC, 2020b), the Farm to Fork Strategy (EC, 2020d), and the Zero Pollution Action Plan (EC, 2021b).

The shift towards sustainability poses significant challenges to policymaking, particularly in the area of overall supply chain impact assessments as well as trade-offs between environmental pressures, impacts, and ways to reduce such impacts (Sala et al., 2021). Life Cycle Assessment (LCA) may be one of the key answers to understanding the issue, since it supports the environmental aspect of LCT. LCA has been used for around 50 years; a recent description is “a comprehensive quantitative method to assess the environmental impacts due to resource use and emissions to the environment

² It is worth noting that such a network is not limited to the mere supply chains required to support the production and trade of a specific product under analysis, but it also includes the additional supply chains required for the quantification of indirect impacts via the products that are necessary for the operation of the supply chains. For example, the life-cycle of a food product may include road vehicles for transportations between different life cycle stages: the life cycle inventory would also include the life-cycle of the road vehicle and associated life-cycle stages, from material extraction to end of life.

along the entire life cycles of systems, products and processes, thereby considering the entire value change: from extraction of raw materials to end-of-life management” (Sanyé-Mengual and Sala 2022). Through the use of LCA, potential trade-offs among life cycle stages or between products can be identified and methods for their mitigation may be recommended. For instance, an improvement in energy efficiency in the use phase might require an increase in the amount of raw materials extracted, and so the resulting benefits have to be weighed. One key strength of using LCA is that it identifies and helps to avoid burden shifting, i.e., where reducing the impacts in one life cycle stage or in a geographical region should help to avoid increases elsewhere (EC, 2021a). This is demonstrated in Figure 5 using the CF model, which shows how the consumption patterns in different areas of consumption (or product groups) differ in their contribution to the environmental impacts assessed in the EU Consumption Footprint. This indicates that changes in consumption patterns, or in the environmental impact of individual products due to policy effects, may lead to positive changes in certain impact categories, whilst potentially incurring trade-offs regarding other environmental impact categories.

Figure 5. Contribution of the areas of consumption to the Consumption Footprint (EU-27, 2022)

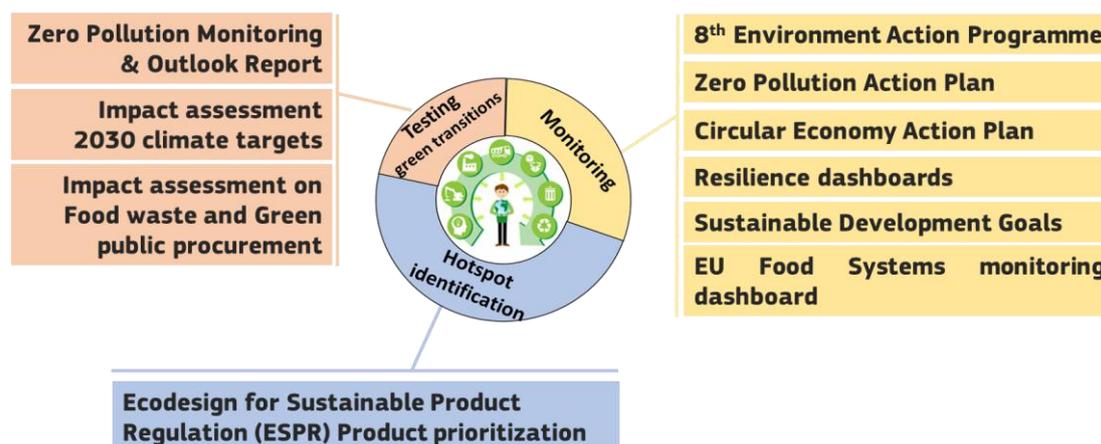


Source: Sanyé-Mengual et al. (2025)

2.3 Policy uses of Consumption and Domestic Footprint models

The DF and CF models have been used in support of several policy exercises in recent years. Both models are included in the Modelling Inventory and Knowledge Management System (MIDAS) of the European Commission³. Specifically, the **CF** and **DF** models can provide support: to **monitoring, hotspot identification and testing scenarios** (Figure 6 - Sanyé-Mengual et.al. 2024). These are briefly outlined in the following sections, together with other potential uses at the Member States and citizen level.

Figure 6. Overview of recent contributions of the Domestic Footprint and Consumption Footprint to EU policies



Source: Sanyé Mengual et al., (2025)

2.3.1 Monitoring

The DF and the CF models generate **headline indicators** for the following EU frameworks: (i) the 8th Environmental Action Programme (EC 2022a, EEA 2025), (ii) the monitoring of the Zero Pollution Action Plan via normalisation against the planetary boundaries (EEA 2022, EEA-JRC 2025), (iii) the Circular economy monitoring framework (Eurostat 2024c), (iv) the Resilience dashboard (EC 2023a), (v) the SDG monitoring framework (Eurostat 2024a), and (vi) the EU Food System Monitoring Dashboard (EC-JRC, 2024a). The indicators are also included in the official public data sources of the European Commission (Eurostat 2024d).

Potential uses for policy support: the indicators are updated every year with a two-year time lag, and support tracking the evolution of environmental impacts associated with EU production and consumption. Typical questions that the models can help to answer may include: (a) by how much is the EU decoupling environmental impacts from economic growth?, (b) what are the potential environmental benefits of the transition towards a greener or more circular economy?, (c) how do consumption and production patterns compare with planetary boundaries?, (d) how is the EU progressing in relation to the Sustainable Development Goals (SDGs), especially SDG12 on responsible consumption and production?. The models can also be employed to set targets for policy purposes, as called for by the European Parliament regarding the implementation of the circular

³ <https://web.jrc.ec.europa.eu/policy-model-inventory/>

economy⁴. At the Member State (MS) level, for example, Sweden's Parliament recently agreed on having a consumption-based perspective for climate targets (SCPC 2024).

2.3.2 Identifying environmental hotspots and prioritization between products

Thanks to its product granularity, the Consumption Footprint has been recently used to prioritise efforts linked to the Ecodesign for Sustainable Products Regulation (ESPR) (EC 2022b, EC 2023d, EC-JRC 2024c). The CF has also been employed to study the societal inequality of people's consumption footprints with respect to socio-economic groupings, by mapping the CF against consumer expenditure and consumption patterns (EC-JRC 2024d).

Potential uses for policy support: the granularity of the CF and DF indicators can provide information on **hotspots at different levels**, i.e., environmental issues with the highest relevance, most relevant resource used or emissions to the environment. The CF also supports the analysis by areas of consumption, product groups and products, or life cycle stages of products. This can provide key insights to prioritise and target policy actions where intervention is most needed. The CF also enables an overview of potential interventions, when exploring sensitivity analyses in impact assessments. The DF further supports the identification of those areas of consumption and production that contribute most to environmental impacts (emissions to the environment and resource use, and extraction). Both the DF and the CF models can provide results in absolute sustainability terms (rather than by relative progress comparison) via assessing impacts against planetary boundaries, thus identifying the most pressing challenges in an overarching assessment exercise, to then prioritise these areas for urgent intervention.

2.3.3 Scenarios and Outlook analysis

The CF has been used recently to perform scenario analyses up to 2030 in several studies. These include the modelling of food waste reduction targets for impact assessment (De Jong et al. 2023), and the Zero Pollution Outlook 2022 for the year 2030 (EC-JRC 2022). This latter includes an assessment comparing the integrated environmental assessment with the planetary boundaries reference framework, and has been extended and updated in for the Zero Pollution Monitoring and Outlook 2024 (EEA-JRC, 2025).

Potential uses for policy support: the modularity of the CF model makes it suitable for the design and analysis of scenarios affecting not only changes in consumers lifestyles but also changes impacting all the different stages along the supply chain (from raw material extraction to end-of-life), as well as technological and design changes in the life cycle of products. On the other hand, the DF model can be used to set a baseline for monitoring domestic impacts or assessing scenarios, such as the expected effect of the circular economy on resource use and climate change emissions. This makes the CF and DF models suitable tools for EU impact assessment across the entire policy cycle, from ex ante assessment to ex post evaluation.

⁴ See Members of Parliaments' call for binding 2030 targets for materials use and consumption footprint, available at <https://www.europarl.europa.eu/news/en/press-room/20210122IPR96214/meps-call-for-binding-2030-targets-for-materials-use-and-consumption-footprint>

2.3.4 Other uses at the level of Member States and Consumers

The CF model can also be used as underpinning tool to support other applications that address the needs of citizens and Members States:

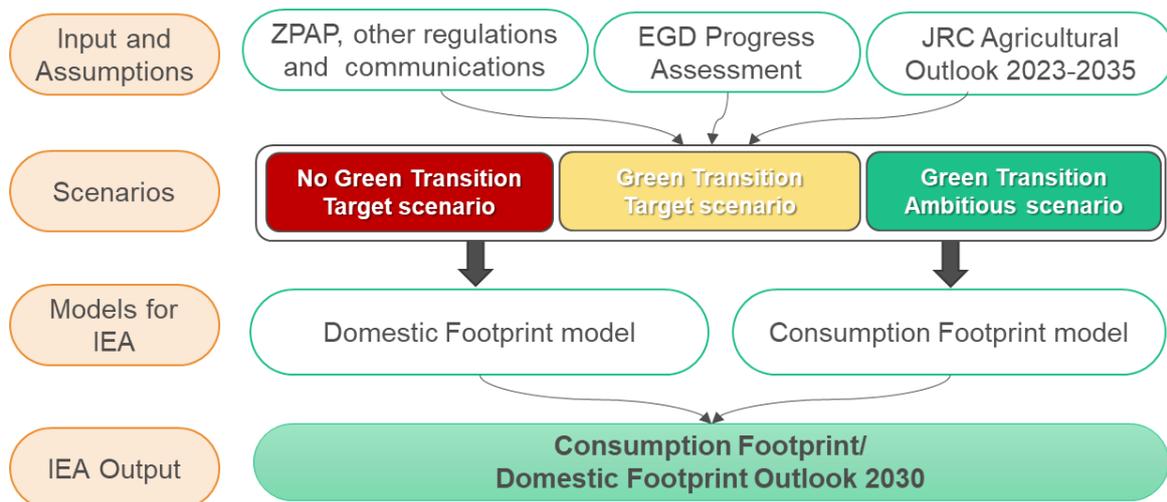
- **Member States' Consumption Footprint tool:** At Member State (MS) level, identifying transboundary and spill-over effects. The model can be customised by MS, using MS-specific consumption data and may be used to further explore the consumption footprint at MS or intra-EU levels, namely the amount of impacts embodied in imported goods (EC-JRC, 2024f, Sanyé-Mengual et al. 2023b)).
- **Consumer Footprint (individual patterns) calculator:** Evaluates consumers' lifestyles and consumption patterns on the scale of the individual. Users can compare their own consumption choices to those of an average EU citizen's lifestyle choices, and also within individual Member States. The Consumer Footprint Calculator and its associated web-based platform is currently available in the 24 languages of the EU. (EC-JRC, 2024e)

3 Methodology – Assessment of Increasing Green Transition Ambitions with an Outlook to 2030

The methodology applied in the current analysis is outlined in Figure 7 below. The present exercise can be considered as an Integrated Environmental Assessment (IEA), since it synthesises a variety of existing environmental impacts, data and their associated uncertainties with the purpose of providing guidance for decision makers on the consequences of varying management actions, including inaction (Boileau et al. 2019)⁵.

The outlook results are derived from three cumulative scenarios (i.e., they build upon each other) with the DF and CF models. The exercise is informed via an analysis of existing regulations and communications linked to the EGD-related EU Green Transition (e.g., the Zero Pollution Action Plan (EC 2021b), Renovation Wave (EC 2020e), progress assessment towards EGD targets (EC-JRC, 2025)) and relevant available modelling exercises (i.e., JRC Agricultural Outlook 2023-2035 (EC 2023e)).

Figure 7. Overview of the integrated environmental assessment: research questions, main data sources, scenarios, models, and output.



Source: JRC elaboration

Specifically, the present analysis aims to answer the following four key **research questions**:

- (a) What is the expected evolution of the EU Consumption Footprint and Domestic Footprint by 2030?

⁵ It is worth noting that the integrated environmental assessment proposed in this report aims to simulate the conditions that can be obtained if a target is reached, but does not provide modelling evidence describing how to reach the target. For example, the simulations do not consider (i) uncertainties linked to the existence of rebound effects or other feedback mechanisms that can influence results (e.g., price change and adaptation due to policy interventions), (ii) product specific policies that compose the CF model in the appliances and housing goods sectors, and (iii) possible uncertainties linked to the calculation of environmental impacts. Additional details are available in Section 9.

- (b) Will the Consumption Footprint and the Domestic Footprint be within the planetary boundaries by 2030 if all green transition legally binding targets and the pesticides reduction targets are achieved?
- (c) Will the Consumption Footprint and the Domestic Footprint be within the Zero Pollution Action Plan (ZPAP) targets by 2030, if current observed trends continue with regard to reaching the EGD-related green transition targets?
- (d) What could be the reduction in environmental impacts if all green transition targets and further ambitions were achieved, and how do these relate to Zero Pollution targets?

This section describes the steps of the methodology in detail, and is supported by Annexes 2, 3 and 4 which give additional detail.

3.1 Selection of targets to be modelled

The analysis presented in this report builds on a review of existing regulations and communications related to the EGD (EC-JRC 2025, including the ZPAP) and selects **50 targets and ambitions, of which 18 targets are modelled with the DF and 37 are modelled with the CF** (34 targets and three ambitions). **Five targets are covered by both** models (see summary overview in Figure 8, then Annex 3 and Annex 4 for details).

Specifically, the Zero Pollution Action Plan (ZPAP) (EC 2021b) is one of the pillars of the European Green Deal, accounting for six targets which were considered in the analysis (Box 1). Considering that the CF is a product-based LCA model, whilst the DF relies on country-level data on territorial environmental pressures that can be aggregated at the EU level, they provide different strengths which make them more or less suitable to model different targets.

Box 1. Zero Pollution Action Plan targets as part of the European Green Deal targets.

- Under EU law, Green Deal ambitions and in synergy with other initiatives, by 2030 the EU should reduce:
- by 50 % nutrient losses, the use and risk of chemical pesticides, the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture
 - by more than 55 % the health impacts (premature deaths) of air pollution
 - by 25 % the EU ecosystems where air pollution threatens biodiversity
 - significantly total waste generation and by 50 % residual municipal waste
 - by 50 % plastic litter at sea and by 30 % microplastics released into the environment
 - by 30 % the share of people non-chronically disturbed by transport noise

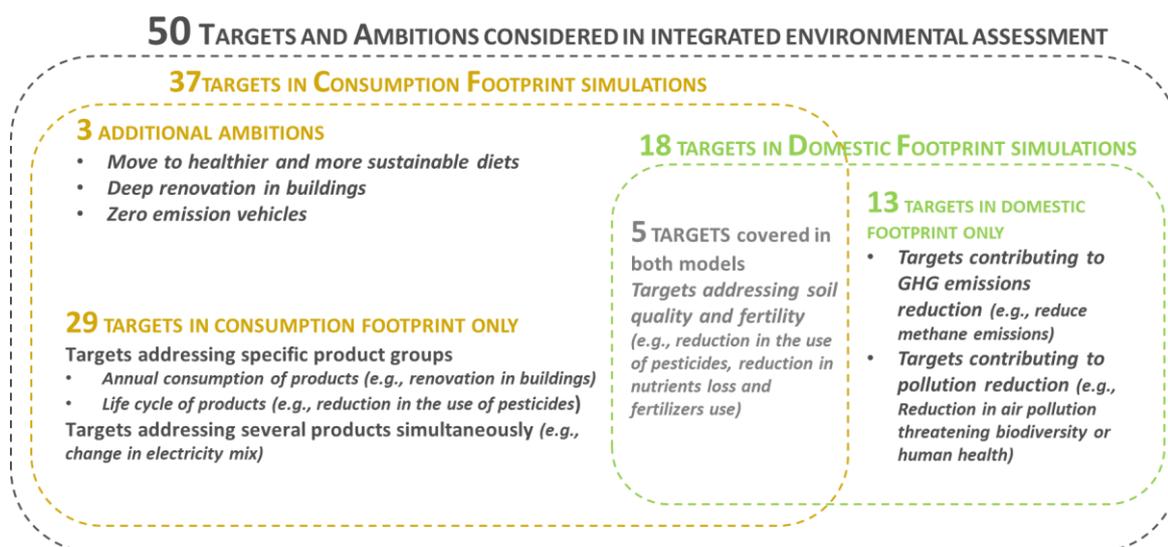
Source: Zero Pollution Action Plan (EC, 2021b)

For example, while the DF is suitable to address a comprehensive target such as the climate reduction target (which covers EU total emissions), the CF can provide better insights on how product-based policies can influence climate change (e.g., increased energy efficiency in building could reduce energy consumption and emissions), but without covering the scope of all EU emissions as a whole. In the context of the ZPAP, the CF and DF models could directly model three targets: combined pesticides, and reduction of loss of nutrients (both models), reduction of impact

to biodiversity (both models), air pollution reduction (DF model), and provide insights linked to the achievement of the target of reduction of total waste and plastic (CF model). Two targets could not be modelled since they were out of scope of both models, because they are not currently addressed in the EF method (the effect of transport noise and the presence of microplastics in the environment).

All targets were modelled as reductions in relation to past data in both the CF and DF models (EC 2021b). Details are available in Annex 5 and Annex 6.

Figure 8. Selection of green transition targets and ambitions modelled for this Integrated Environmental Assessment.



Source: JRC elaboration.

3.2 Inputs to the Integrated Environmental Assessment (IEA) simulation

Both the CF and DF models rely on historical data and statistics to calculate environmental impacts: for the CF these comprise the values of the stocks and annual consumption of products, such as vehicle fleet, or amount of appliances in use; for the DF these consist of environmental pressures such as resource use, and emissions to the environment. Therefore, an important element of the IEA was to develop suitable methods and assumptions to project possible trends of these statistics up to 2030, as detailed in Annex 3 and Annex 4. The following sources were used:

Consumption Footprint model:

- **Agricultural Outlook 2023:** specifically, this study employs agricultural production projections to 2030 to provide a coherent proxy for product annual consumptions for agricultural products. It also uses the projection provided by the JRC Potencia dynamic model in relation to energy data, mobility and housing stock, used to inform the same report (EC, 2023e).
- **Projections from official statistics as a proxy for other variables:** the CF model spans across the entire economy. Trends in consumption of the product categories that could not be covered by the Agricultural Outlook 2023-2035 (EC, 2023e) were estimated using projections from Eurostat. For example, the real disposable income variables available in official statistics we used as a proxy to extrapolate household goods consumption data.

Domestic Footprint model:

- **Projections from historical data:** since the DF model builds on a collection of official EU and Member State statistics and derived modelling, estimates of impacts which did not link to the policy targets were performed by projecting historical DF values using a combination of linear and non-linear extrapolation, often combined with the modelling of specific targets in 2030. For example, the impact category ‘mineral and metals resource use’ (that did not link to any target considered for the DF model) was assumed to follow past trends up to 2030.

3.3 Resulting scenarios for the analyses

The selected green transition targets were represented across three different scenarios designed to answer the four research questions, allowing an illustrative analysis of the environmental impacts of the selected targets (see Figure 8). All scenarios are compared with the planetary boundaries to provide a reference framework for drawing attention to those environmental impacts with potentially higher policy concerns. The scenarios considered are:

- **No Green Transition Targets (NO GTT):** this scenario assumes the continuation of existing trends before the implementation of the green transition targets, and provides a reference for the scenario analysis, by measuring the potential environmental benefits that can be achieved by green policies. Furthermore, it allows to explore changes in policy implementation due to unexpected circumstances (e.g., conflicts, pandemic), as observed in the last decade.
- **Green Transition Targets (GTT):** this scenario includes all the **legally binding targets** by 2030. To these, the reduction in the use of pesticides as well as the reduction of impact of air pollution on human health are added, due to their importance for zero pollution, as these are considered as on track to be achieved (EC-JRC 2025). Compared to the “No GTT” scenario, the GTT scenario helps to measure the environmental benefits that are expected to be achieved by green policy efforts, supporting the capacity to **answer questions (a), (b), and (c)**.
- **Green Transition Targets Ambitious (GTT+):** this scenario expands the scope of the GTT scenario by assuming also the achievement of all non-legally binding targets (i.e., from proposals and communications) as well as further ambitions (e.g., a change in food diet, deep renovation in buildings). Compared to the GTT, this scenario helps to quantify the additional opportunities that could be achieved if more efforts were implemented, and **answers question (d)**.

3.4 Modelling targets

The three scenarios presented in the previous section differ from each other as they gradually include the modelling of selected green transition targets in both models. This section provides an overview on how these targets have been included in the respective scenarios, for both the Consumption and the Domestic Footprint models. Further details on how the targets were modelled are available in Annexes 2, 3 and 4. Due to the overarching architecture of the CF models, which is composed by the five areas of consumption (food, mobility, housing, household goods and appliances), the targets are presented separately for every group of products, with a final section describing the cross-cutting targets common to different areas of consumption.

3.4.1 Overview of the targets modelled in the Domestic Footprint Outlook

The inclusion in the various scenarios of the **18 targets** modelled in the DF is shown in Table 1. It is worth noting that these targets are collected from relevant EU legislation (see EC-JRC 2025), and sometimes present overlaps amongst one other in the context of introducing them in the models. For example, although the achievement of the climate emissions reduction target is covered by ten targets present in different legislative documents, it is introduced as a single entry in the DF model to avoid overlaps and double-counting, as explained in detail in Annex 3. Based on this logic the DF represents **three targets** are linked to the reduction in use of pesticides, **one target** is linked to the reduction of air pollution on human health, and **10 targets** are linked to **climate neutrality**. All of these targets are assumed to be achieved in the **GTT scenario**.

Four targets linked to reduction in nutrient loss, reduction in fertilizer use, land use change, and effects of air pollution on biodiversity are included in the **GTT+ scenario**. It is worth noting that the **No GTT** scenario may, or may not, achieve the targets that are included in the other scenarios due to the underlying assumptions that the “No GTT” patterns will follow past declining trends. For example, the continuation of trends in the impact category of acidification reduction may imply that the target is actually reached even in the “No GTT” scenario.

Table 1. Modelled green transition targets in the Domestic Footprint.

Modelled Target in Domestic Footprint	Legally binding	GTT	GTT+
Reduce by 50% the use and risk of chemical pesticides (<i>Due to the coverage of this target in different policy documents, it embeds the modelling of three green transition targets as detailed in Annex 3</i>).	No	X	X
Reduction of 55% greenhouse gas (GHG) emissions compared to 1990 levels (<i>Due to the coverage of this targets it embeds the modelling of ten green transition targets as detailed in Annex 3</i>).	Yes	X	X
Improve air quality to reduce the number of premature deaths caused by air pollution by 55%.	No	X	X
Reduce by 25% the EU ecosystems where air pollution threatens biodiversity.	No		X
Reach “no net land take”.	No		X
Reduction of 50% in nutrient losses.	No		X
Reduction of 20% in the use of fertilizers.	No		X

Source: JRC elaboration. Note: The symbol ‘**X**’ indicates that the target is assumed to be reached in that scenario.

3.4.2 Overview of the targets modelled in the Consumption Footprint

The CF is a full bottom-up LCA model, meaning that it relies on a supply chain perspective, which models the different life cycle stages (from the extraction of raw materials to product end of life) for each representative product, to calculate the environmental impact of a unit of that product. The resulting values are multiplied by the annual consumption of those products (via sales/ imports as well as stock statistics), which provides a macro-scale perspective on the environmental impact of consumption related to the areas of consumption being considered.

The annual consumption patterns are projected to 2030 with the method described in Annex 4 of this report. In parallel, the LCA component of the model is also equipped with parameters related to

the allocation of resources and emissions along life cycle stages, and can be varied to test different scenarios as well as uncertainties. For example, the production of food products requires certain quantities of pesticides per kilogramme of output, which leads to the associated emissions to land as well as an environmental impact due to the manufacturing and supply of those pesticides, etc.

The modelling of the **NO GTT** scenario assumes the continuation of trends of annual consumption of products, and considers that the values of the parameters that control the environmental impacts of LCA processes for every product do not influence results. Thus, this scenario provides a reference condition in 2030 as if no green transition policy efforts were considered.

On the contrary, parameter values associated with the **GTT scenario** (usually better from a sustainability perspective via reduced environmental impacts) are used as inputs to the model for the **GTT** and **GTT+** scenarios. Therefore, these scenarios map the achievement of the selected targets and related improvements, which are described in the tables below and in Annex 4. As in the case of the DF model, targets collected from relevant EU legislation may overlap amongst one another in the context of the CF model, resulting in one single entry to capture sets of targets, as represented in bold in the tables below.

3.4.2.1 Mobility

In the context of mobility, **three targets** are considered (see Table 2). The achievement of targets on **advanced biofuels and biogas** and **sustainable aviation fuels** were modelled as achieved in **GTT** scenario, and the ambition of achieving **30 million electric cars on the road** is considered in the **GTT+** scenario.

Table 2. Modelled green transition targets in the mobility basket of products of the Consumption Footprint.

Modelled Target in Consumption Footprint	Legally binding	GTT	GTT+
Each Member State shall set an obligation on fuel suppliers to ensure that: the combined share of advanced biofuels and biogas produced from the feedstock listed in Part A of Annex IX and of renewable fuels of non-biological origin in the energy supplied to the transport sector is at least 1 % in 2025 and 3,5 % in 2030.	Yes	X	X
Starting from 2025, at least 2% of aviation fuels will be “green”, with this share increasing every five years: 6% in 2030, 20% in 2035, 34% in 2040, 42% in 2045 and 70% in 2050. Hydrogen and fuel produced from cooking oil or waste gases are considered as “green”.	Yes	X	X
There will be at least 30 million zero-emission cars and 80000 zero-emission lorries in operation.	No (Ambition)		X

Source: JRC elaboration. Note: The symbol ‘**X**’ indicates that the target is assumed to be reached in that scenario.

3.4.2.2 Food

A total of **nine green transition targets and ambitions** are modelled in the food basket of products of the CF model. Due to its importance to the analysis of zero pollution, the **reduction in use of pesticides** is included in the **GTT scenario**. **Pesticides reduction** is covered by three different targets since it is referred to in several policy documents (see EU Soil strategy for 2030 (EC 2021d), Biodiversity Strategy (EC 2020a), and Zero Pollution Action Plan (EC 2021b)) is included in the **GTT scenario**. The other **five targets** linked to **reduction in nutrient loss, expansion of organic farming, reduction in food waste**, as well as the additional **ambition to move to a healthier and more sustainable diet** are included in the **GTT+** scenario.

Table 3. Modelled green transition targets in the food basket of products of the Consumption Footprint

Modelled Target in Consumption Footprint	Legally binding	GTT	GTT+
Reduce by 50% the use and risk of chemical pesticides <i>(Due to the coverage of this target in different policy documents, it embeds the modelling of three green transition targets as detailed in Annex 4).</i>	No	X	X
Reduce the generation of food waste in processing and manufacturing by 10% in comparison to 2020.	No		X
Reduce the generation of food waste per capita, jointly in retail and other distribution of food, in restaurants and food services and in households, by 30 % in comparison to 2020.	No		X
Increase organic farming with the aim to achieve at least 25% of total farmland under organic farming by 2030.	No		X
The losses of nutrients from fertilisers are reduced by 50%, resulting in the reduction of the use of fertilisers by at least 20% <i>(Due to the large coverage of this target in different policy documents, it embeds the modelling of two green transition targets as detailed in Annex 4).</i>	No		X
Move to healthier and more sustainable diets.	No (Ambition)		X

Source: JRC elaboration. Note: The symbol '**X**' indicates that the target is assumed to be reached in that scenario.

3.4.2.3 Housing

In the context of housing, **five targets** are considered (see Table 4). One **target** is linked to the **use of renewable energy in buildings**, and is considered to be achieved in the **GTT** scenario. **Four targets** that represent the ambition of renovation wave (e.g., **reducing final energy and heat energy consumption in buildings**, as well as **increasing the rate of expansion of energy efficient building up to achieving deep renovation in 35 million building**) were modelled in the **GTT+** scenario. It is worth noting that the use phase (e.g. space heating) of housing represents the major hotspot for the environmental impact of domestic buildings, leading to the greatest opportunity for green transition at the EU level.

Table 4. Modelled green transition targets in the housing basket of products of the Consumption Footprint.

Modelled Target in Consumption Footprint	Legally binding	GTT	GTT+
Member States must determine an indicative national share of renewable energy produced on-site or nearby, as well as renewable energy taken from the grid, in final energy consumption data in their building sector in 2030, to be consistent with an indicative target of at least a 49 % share of energy from renewable sources in the building sector in the Union's final energy consumption in buildings in 2030	Yes	X	X
Reduce buildings' final energy consumption by 14%	No		X
Reduce buildings' energy consumption for heating and cooling by 18%	No		X
At least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations	No		X
Indicative national targets aiming to achieve the deep renovation of at least 35 million building units by 2030 to support reaching an annual energy renovation rate of 3 % or more for the period till 2050	No (Ambition)		X

Source: JRC elaboration. Note: The symbol 'X' indicates that the target is assumed to be reached in that scenario.

3.4.2.4 Cross cutting: energy, transport, waste treatment, recycling and packaging

Table 5 shows the **20 cross-cutting targets** (i.e., those targeting more than one basket of products in the CF). From a modelling perspective, the achievement of eight legally-binding targets results in the achievement of nine non-legally binding targets. Six non-legally binding packaging recycling targets on specific materials are achieved via modelling the legally-binding targets on **landfill reduction** and **overall packaging recycling**. Also, the **expansion of renewables in the energy mix** (due to a legally binding target) means that two other non-legally binding renewables expansion targets are met).

Overall, **17 targets** are modelled as being achieved in the **GTT scenario**.

The **GTT+ scenario** also includes the achievement of **three** other targets on expanding **wind energy, geothermal**, and **further renewables** in the renewable energy mix. .

Table 5. Modelled green transition targets in the energy and waste treatment of the Consumption Footprint.

Modelled Target in Consumption Footprint	Basket of Products (BoPs)	Legally binding	GTT	GTT+
Member States shall collectively ensure that the share of energy from renewable sources in the Union's gross final consumption of energy in 2030 is at least 42,5 %.	All BoPs	Yes	X	X
Bring online over 320 GW of solar photovoltaic by 2025 and 600 GW by 2030 (considered achieved in GTT due to previous target)	All Bops	No	X	X
Over this decade, the EU will need to install, on average, approximately 45 GW per year of PV to reach the share of 45% of energy coming from renewables set out in the RePowerEU Plan (considered achieved in GTT due to previous target)	All Bops	No	X	X
Recycling shall achieve at least the following targets for recycling efficiency: [...] No later than 31 December 2030 80% by average weight of lead-acid batteries.	Mobility, Appliances	Yes	X	X
All recycling shall achieve at least the following targets for recovery of materials. [...] No later than 31 December 2031: (iii) 95% for cobalt, copper, lead, and nickel.	Mobility, Appliances	Yes	X	X
Recycling shall achieve at least the following targets for recycling efficiency: [...] No later than 31 December 2030, 70% by average weight of lithium-based batteries.	Mobility, Appliances	Yes	X	X
Reduce landfill to a maximum of 10% of municipal waste (by 2035)	All Bops	Yes	X	X
Recycling or preparing for re-use 65% of all packaging waste by 2025, 70% by 2030 (this target embeds the modelling of four green transition targets as detailed in Annex 4)	Food, Appliances, Household goods	Yes	X	X
Recycling of aluminium in packaging: 60% Recycling of ferrous metals in packaging: 80% Recycling of glass in packaging: 75% Recycling of paper and cardboard in packaging: 85% Recycling of wood in packaging: 30% (these six targets are considered as achieved in GTT due to the fulfilment of previous target on landfill reduction and recycling)	Food, Appliances, Household goods	No	X	X
By 2030, the share of renewable energy in the electricity mix should double to 55-60% [...]	All BoPs	No		X
Energy demand to be covered by solar heat and geothermal should at least triple	All BoPs	No		X
The strategy sets targets for an installed capacity of at least 60 GW of offshore wind by 2030.	All BoPs	No		X

Source: JRC elaboration. Note: The symbol 'X' indicates that the target is assumed to be reached in that scenario.

4 Reference condition (historical data as of 2022)

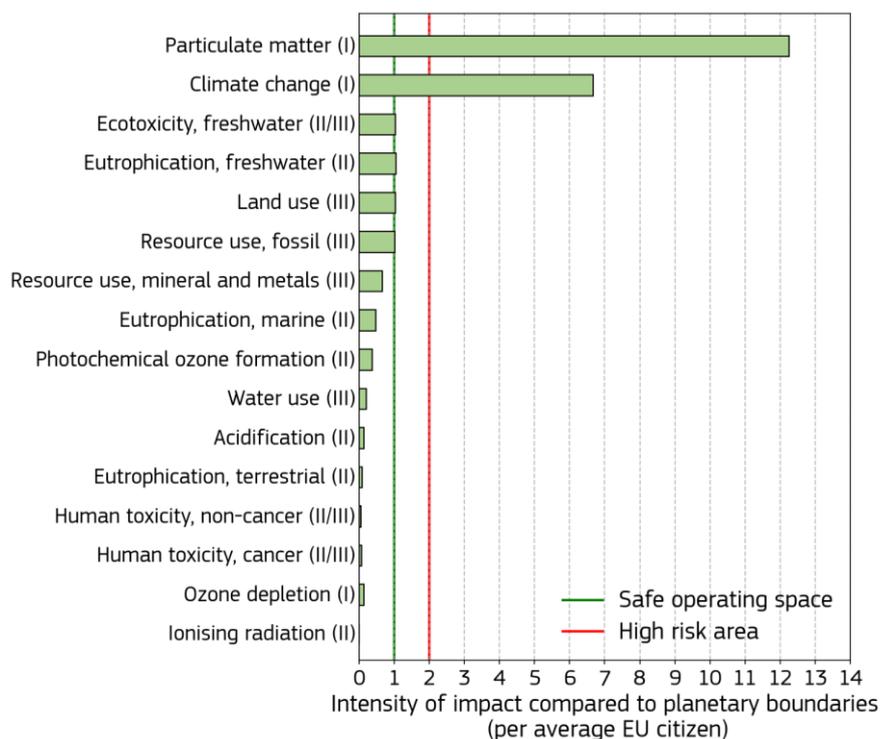
The reference condition of the outlook scenarios to 2030 consists of the historical data in 2022. The analysis compares the environmental impacts with the planetary boundaries. It is worth noting that the DF and the CF models are not intended to be compared in absolute terms one with the other, e.g. when assessed against the planetary boundaries or ZPAP targets. This is due to (i) the different approach to modelling of the two models (territorial vs. consumption), (ii) the different scope in terms of environmental pressures (e.g. the pressures associated to one impact category might be better covered in the DF compared to the CF, owing to the granularity of its statistics, and vice versa), and (iii) the two models have a different scope in terms of economic activities (the DF covers all activities within the EU's boundaries, while the CF focusses on consumer products).

The above differences result in two sets of outputs from the two models across all impact categories, despite the fact that they generally provide similar conclusions at the “magnitude of concern” level, e.g., both models show that particulate matter and climate change are well in excess of the related planetary boundaries.

4.1 Comparison with planetary boundaries

Figure 9 and Figure 10 show the 2022 environmental impacts in relation to planetary boundaries of the DF and CF models for the 16 EF impact categories. With regard to the DF, **two categories** that lie above PB are **particulate matter (12 times higher than PB)** and **climate change (7 times higher than PB)**. These are followed by four impact categories which lie at the threshold of the “safe operating space”: **freshwater eutrophication and eco-toxicity, land use, and use of fossil fuel resources**.

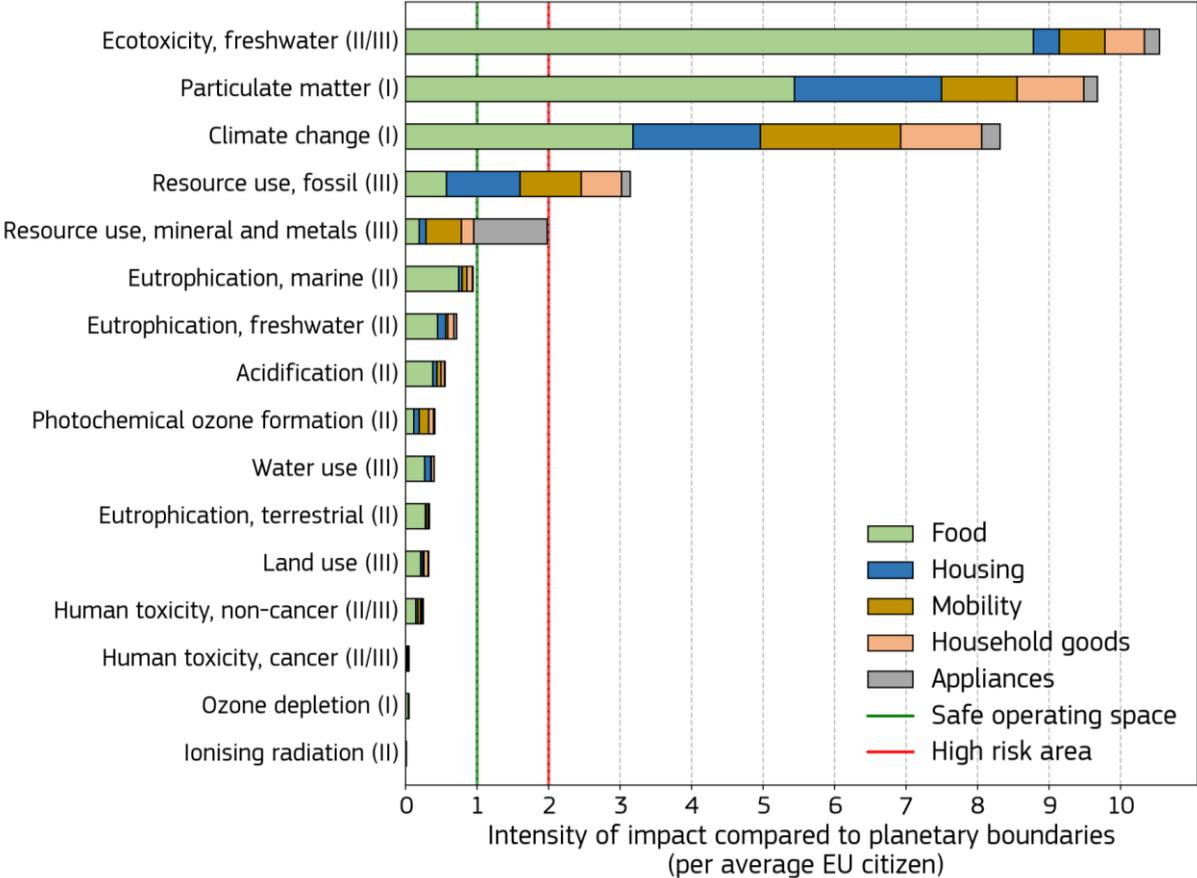
Figure 9. Domestic Footprint comparison with planetary boundaries in 2022



Source: Consumption Footprint Platform (EC-JRC, 2024b). Model robustness between 'I' (or high confidence) and 'III' (or low confidence) of the impact assessment model used to assess each indicator is taken from EC (2021a)

The environmental impact significantly worsens when exploring the overall effects of consumption via the CF. **Freshwater ecotoxicity** is highlighted as the category which is most at risk (**ten times higher than PB**). This is followed by **particulate matter (ten times the PB)**, **climate change (eight times the PB)**, **fossil fuel resource use (three times the PB)**, and **mineral resource use (twice the PB)**. It is worth noting how the CF can show the greater impact of food products, housing and mobility which span beyond planetary boundaries by multiple factors.

Figure 10. Consumption Footprint comparison with planetary boundaries in 2022, and contribution of each basket of products.



Source: Consumption Footprint Platform (EC-JRC, 2024b). Model robustness between 'I' (or high confidence) and 'III' (or low confidence) of the impact assessment model used to assess each indicator is taken from EC (2021a)

5 Domestic Footprint Outlook

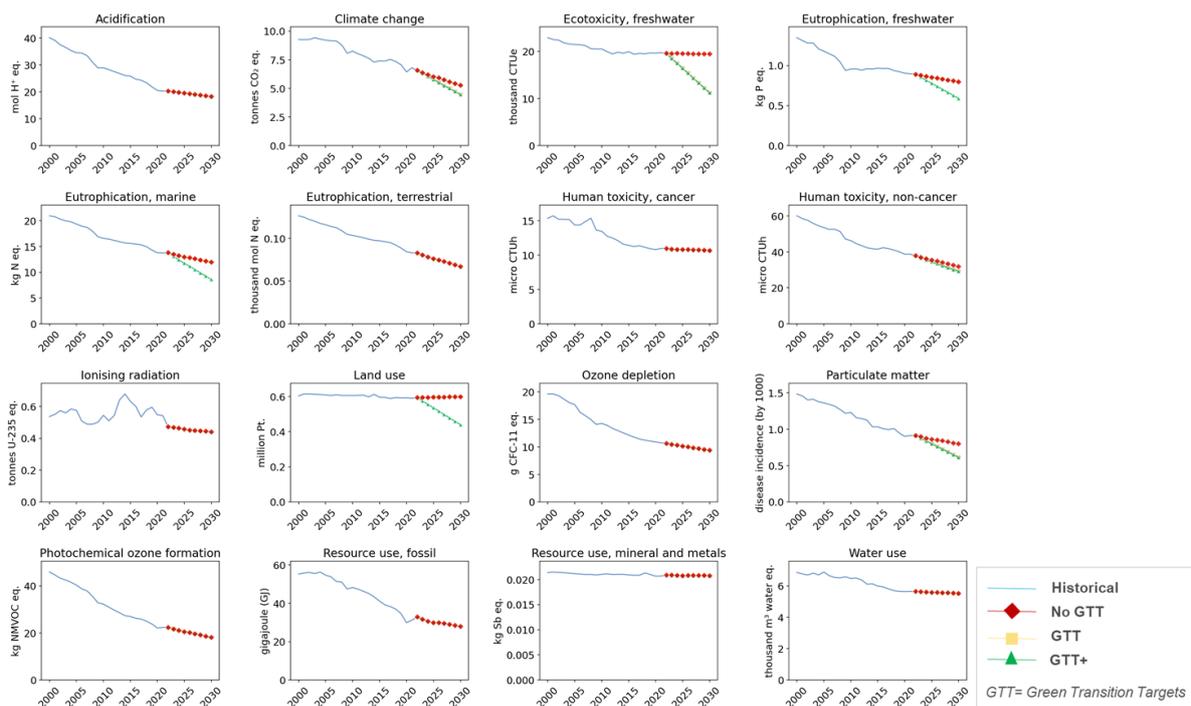
The DF is based on a detailed collection of Member State-specific statistics, as well as being complemented with the modelling of environmental pressures. In contrast to the CF, the more top-down DF model design does not allow the bottom-up tweaking of component parameters, which by comparison limits its use for testing scenarios.

The **No GTT** scenario in the DF was modelled by means of linear regression (for those impact categories which showed a linear trend) and log-linear regression (for impact categories that exhibit slower rates of change) of historical data projected to 2030 (details are available in Annex 3). The modelling of the **GTT** and **GTT+** scenarios (see Annex 3) consisted of projecting the values of specific substances that comprised the DF inventory, to represent the achievement of the considered targets. For example, to model the 50% reduction in the use of pesticides, the inventory of substances connected to pesticides at year 2017 of the DF was simply halved to calculate the target of pesticides by the year 2030, but no associated differences or improvements in the supply chain or the efficacy of the pesticides were included in the modelling assumptions. The following sections describe the results of this approach.

5.1 Trends in the Domestic Footprint

The historical data of the DF (see Figure 11) show decreasing trends for 15 out of the 16 impact categories of the EF from year 2000 to 2022 (Sanyé-Mengual et al. 2025). The only category which does not show a decline in its values is that of mineral resources use, which exhibits stability. As a result, the **No GTT** scenario projects these declining trends up to 2030, with the underlying assumption being that although no account is made for additional green transition measures, the overall projection would still result in declining trends in environmental impacts over time.

Figure 11. Domestic Footprint: historical trend and outlook in 2030 in terms of No GTT, GTT, and GTT+ ambitions scenarios.



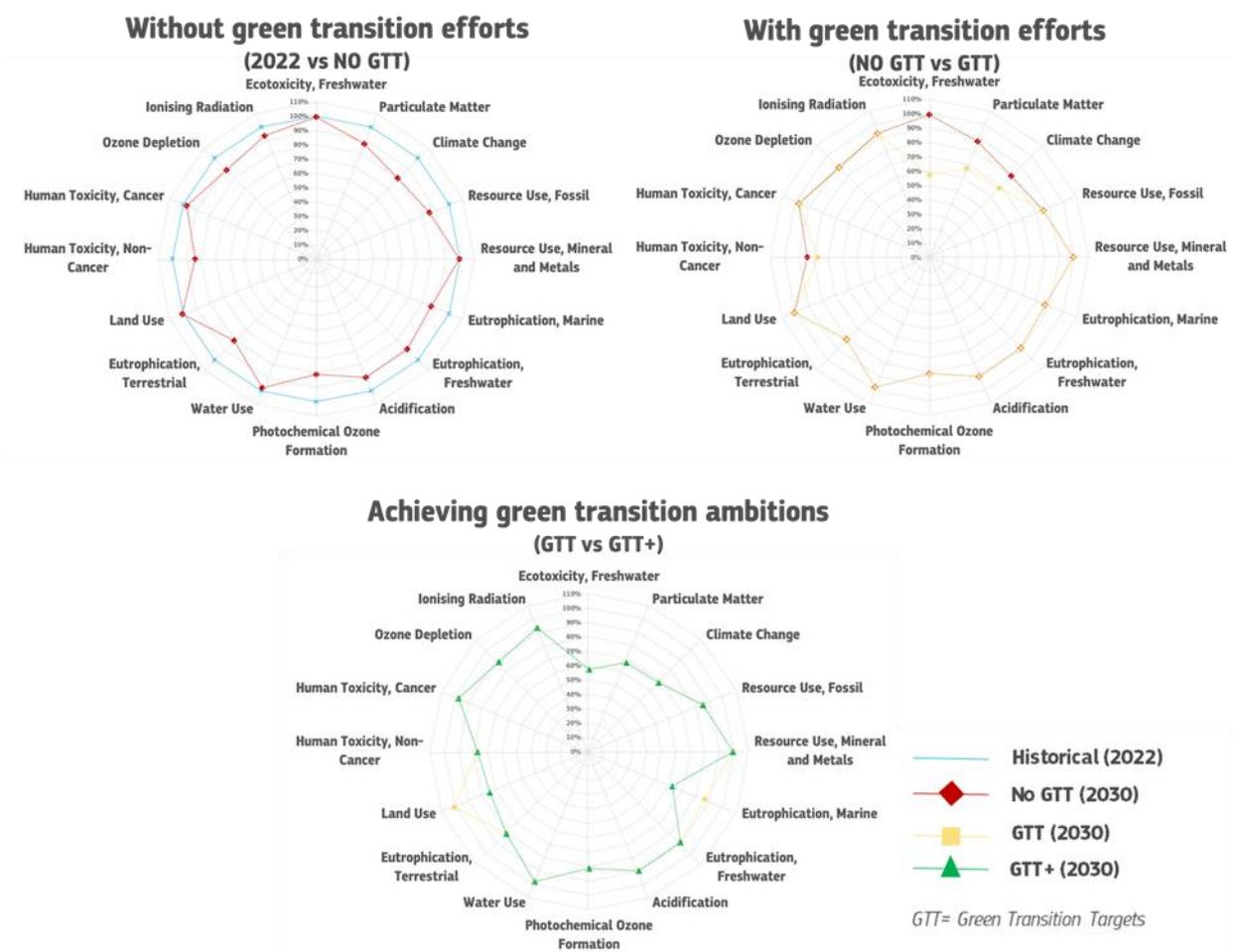
Source: JRC elaboration.

Because of this assumption, some green transition targets considered in the DF outlook appear to be met already in the **No GTT** scenario which overlaps with the other scenarios across multiple impact categories (see Annex 3 for details). When a target is not met in the **No GTT**, then it is considered as being achieved in the respective scenario.

The three scenarios show a progressive improvement in the possible results. Such a situation is well visible by progressively comparing the cumulative scenarios one to another (Figure 12. Domestic Footprint outlook comparing the four scenarios to 2030. Figure 12). While the difference between historical data in 2022 and **No GTT** in 2030 (top-left quadrant in figure) shows that **without green transition efforts**, a reduction in environmental impact would be visible between 2022 and 2030. However, when considering the expected effect of **GTT efforts** (top right quadrant in Figure 12) it becomes evident how GTT policy is expected to provide further benefits in terms of reduction of environmental impact.

Compared to 2022, this is translated in a **-43% in freshwater ecotoxicity, -33% in terms of particulate matter, -10% in terms of acidification** and **-23% in terms of non-cancer human toxicity**. Most of the results depend on meeting the target reduction of pesticides in agriculture (50% reduction in use of fertilisers), and the reduction in the number of premature deaths caused by air pollution by 55%.

Figure 12. Domestic Footprint outlook comparing the four scenarios to 2030.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

Additional opportunities are shown at the bottom of Figure 12 when comparing the targets to the ambitions. Compared to 2022, an additional **25% reduction in land use** and an additional **20% reduction in marine eutrophication** could be obtained, if achieving the ambitions of 50% less nutrient loss, 20% less use of fertilizers, and the no net land take target (this latter by assuming no further urban development which may decrease land use for agriculture, pasture, fallow land and forests).

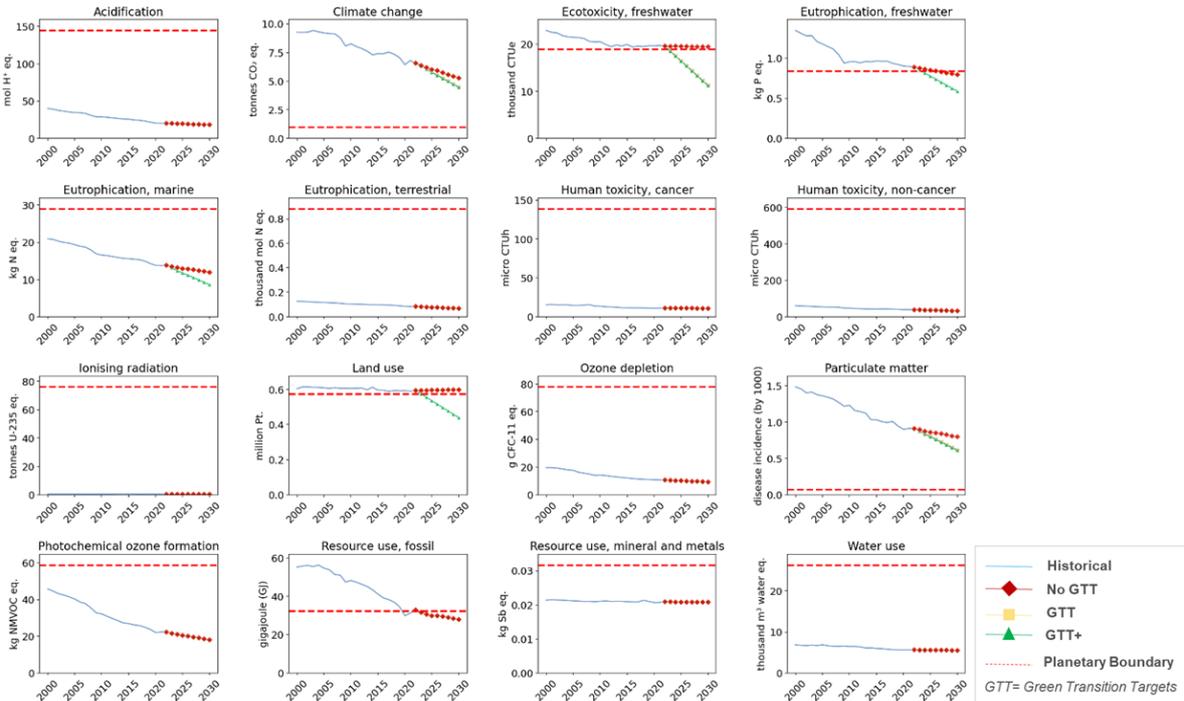
The improvement of **GTT** and **GTT+** scenarios compared to **NO GTT** confirms that **green transition policy is further expanding the efforts of environmental policy** by ensuring the progress over time and reinforcing progress in specific areas of consumption.

5.2 Domestic Footprint and Planetary Boundaries

Figure 13 compares the historical trend and three scenarios of the outlook with the relative planetary boundaries thresholds as calculated in Sanyé-Mengual et al. (2025). The outlook shows that **two (freshwater eutrophication and fossil fuel resource use) out of the six impact categories that lie above planetary boundaries** thresholds could potentially reduce their impact and return within the safe operating space already via the **No GTT** scenario (this is true due to assuming that historical trends continue, and reflecting the positive results of current policy efforts).

The influence of GTT ambitions supports two additional categories that are above the planetary boundaries in 2022 to return to the respective safe operating space (**land use**, and **freshwater eco-toxicity**), and further bring the impact of **climate change** and **particulate matter** towards PBs. Despite these positive results, climate change and particulate matter would still remain very much above PB thresholds (by a factor of four and six respectively) even in the **GTT+ scenario**.

Figure 13. Domestic Footprint outlook and planetary boundaries.



Source: JRC elaboration.

6 Consumption Footprint Outlook

The projections generated with the CF provide a different and complementary perspective to those produced with the DF. This is due to the different scope and the level of granularity of the data structure, distinguishing the 164 representative products distributed across the five areas of consumption, as well as the detailed life cycle data for each stage of every product.

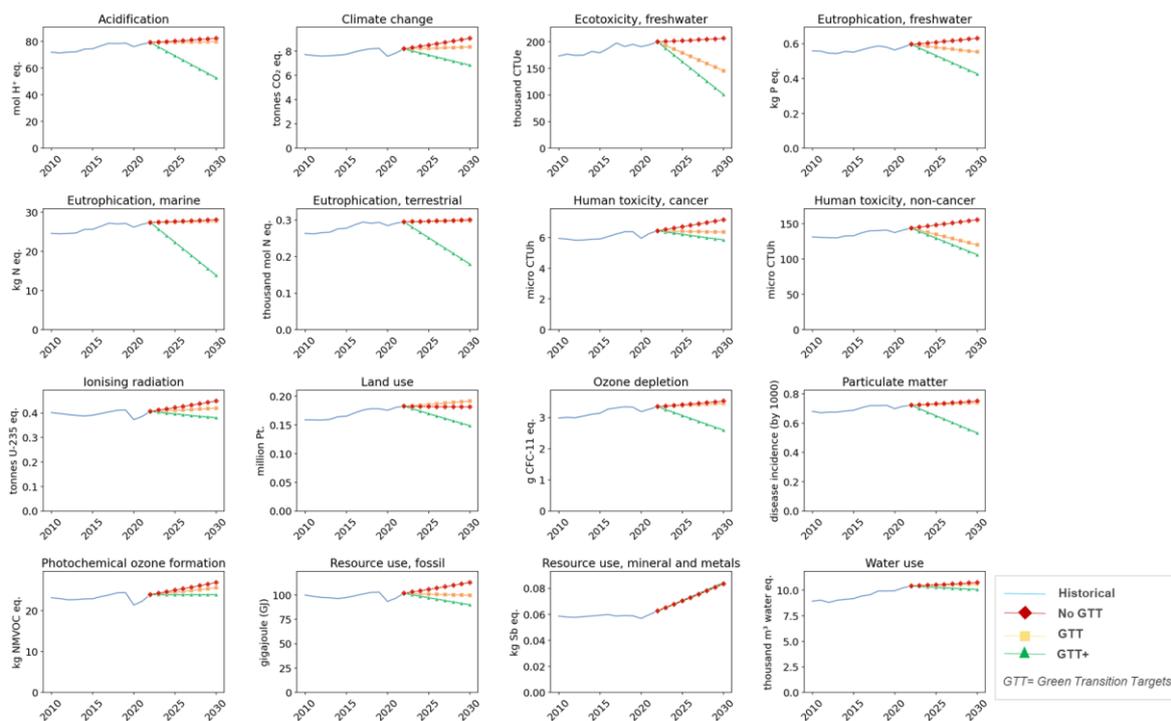
The combination of (i) official statistics of the annual consumption and stock of products, and (ii) the relationships in the product-specific LCA models provide a richer framework than the DF to model with respect to green transition targets and relative scenarios (see Annex 2 for more details).

As described in Section 3.2 above, in the **No GTT** scenario, the annual consumptions of products in 2030 were projected by relying on existing JRC models and studies (see Agricultural Outlook 2023–2035 (EC, 2023e) as well as on official statistics. With regard to the LCA component of the model, the value of specific parameters was varied to model the green transition targets in the **No GTT**, **GTT** and **GTT+** scenarios. Examples include the share of biofuels in cars, or the amount of pesticides used in the cultivation of food products). Details of the approach used to model every target are available in Annex 4.

6.1 Trends in the Consumption Footprint towards 2030

Figure 14 shows the difference in trend for the 16 impact categories of the EF method for the CF, including both the historical data and the **No GTT**, **GTT** and **GTT+** calculated trends. The graphs show, for each impact category, the relationship between the upward trend in the historical data from 2010 to 2022, and the trends up to 2030 in the three scenarios, thus describing the path ahead if the considered targets are assumed to be reached.

Figure 14. Consumption Footprint model results: historical trend and outlook in 2030 for of No GTT, GTT, and GTT+ scenarios.



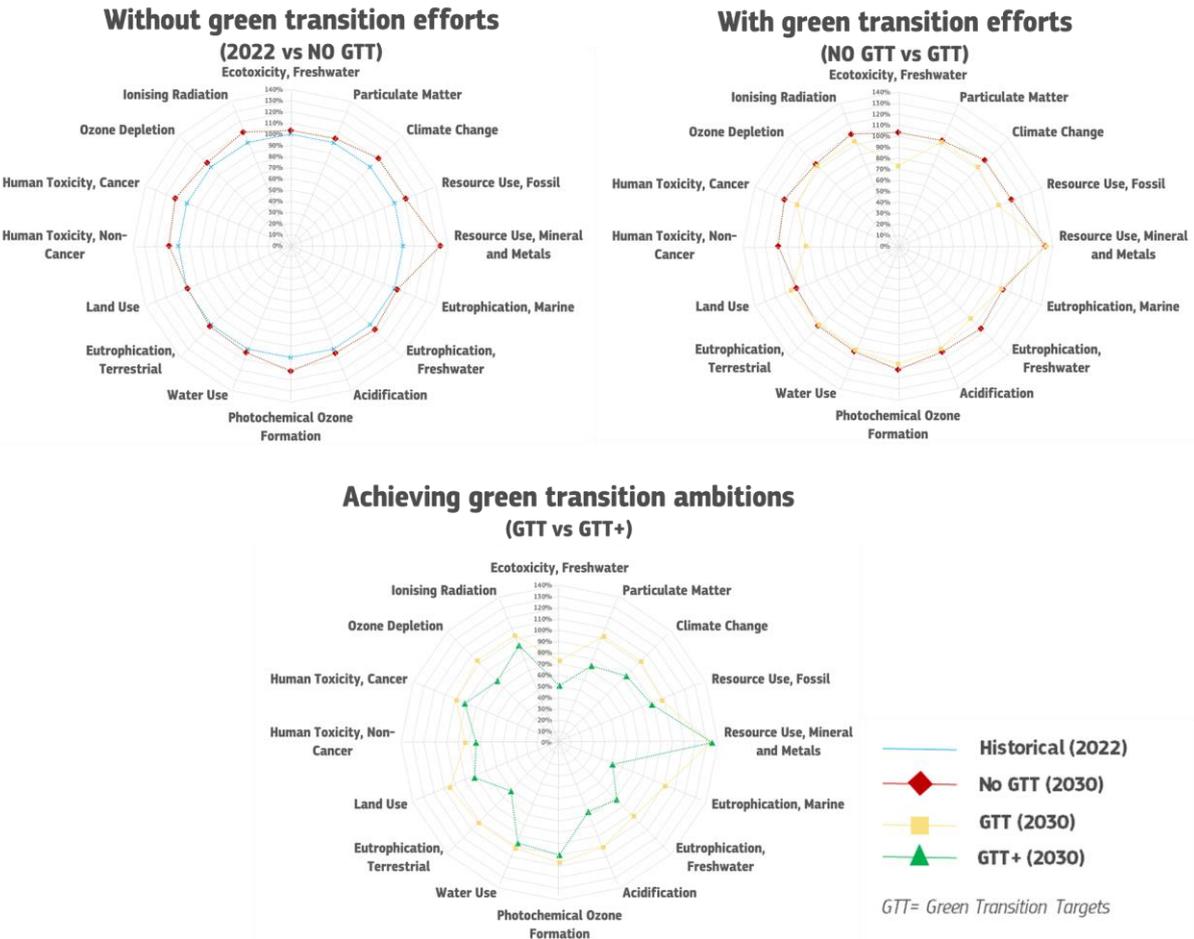
Source: JRC elaboration.

Comparing scenarios two by two (see Figure 15), it is possible to see how **without green transition efforts** (top left comparing **2022** vs **No GTT** scenario in **2030**), the consumption growth across all areas of consumption drives greater environmental impact across all 16 EF impact categories. The variation ranges up to +10% increases across 15 of the impact categories. However, an even greater concern is that mineral resources use is expected to rise by +35% in 2030 compared to 2022.

These plots show evidence of the positive results of **green transition efforts** (top right in figure – when comparing **No GTT** vs **GTT** scenarios in 2030), indicating a reduction in environmental impacts, visible in some pollution-linked categories (i.e., a -30% reduction in ecotoxicity freshwater against **No GTT**, and -25% against **2022**; -25% in non-cancer toxicity against **No GTT**, and -15% against **2022**; -18% in eutrophication freshwater against **No GTT**, and -8% against **2022**).

With regard to the other impact categories, green transition efforts appear to offset the effects of consumption growth in the **NO GTT** scenario, whilst keeping environmental impact at a similar level to that of 2022 for 10 categories (i.e., acidification, climate change, eutrophication marine, eutrophication terrestrial, ionizing radiation, ozone depletion, particulate matter, photochemical ozone formation, fossil fuel use, and water use).

Figure 15. Consumption Footprint outlook comparing the three scenarios in 2030 with historical data in 2022.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

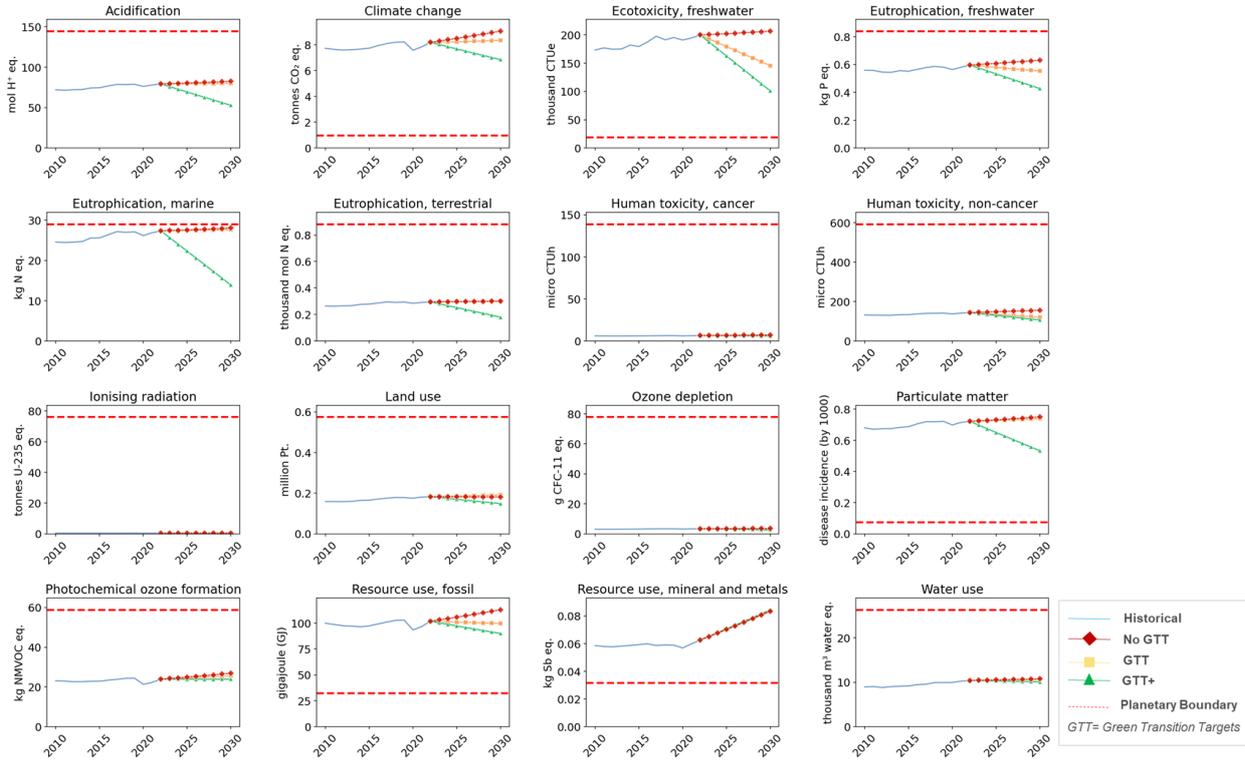
The additional opportunity that could be gained by 2030, via **achieving the green transition targets and ambitions considered in this exercise (GTT+)** appears to be very large across **15 impact categories**; substantial differences are noted compared to **GTT**. In the **GTT+ scenario**, Impacts decline up to a maximum of -50% compared to 2022 (see eutrophication-marine), and generally are reduced by about 5% to 20% for the other impact categories.

The only impact category which remains of concern is that of mineral and metal resource consumption, which remains at a similar level in all scenarios (i.e., around +35% compared to 2022). This is to be expected, because the energy transition relies on technologies which depend on the consumption of additional minerals and metals (e.g., to produce more renewable energy). In other words, the results indicate that the shift in the energy transition does not reduce the absolute impact that EU consumption may have on the consumption of minerals, partly because the energy transition requires the greater use of mineral resources whilst diminishing the direct use of fossil fuels (e.g., in batteries for vehicles and transportation, compared to internal combustion engines).

6.2 Consumption Footprint and Planetary Boundaries

In this section, the results are further compared with planetary boundaries. Figure 16 shows the time series from 2010 to 2030 across the 16 impact categories of consumption, and Figure 17 provides a breakdown of the impact of all area of consumption in these scenarios.

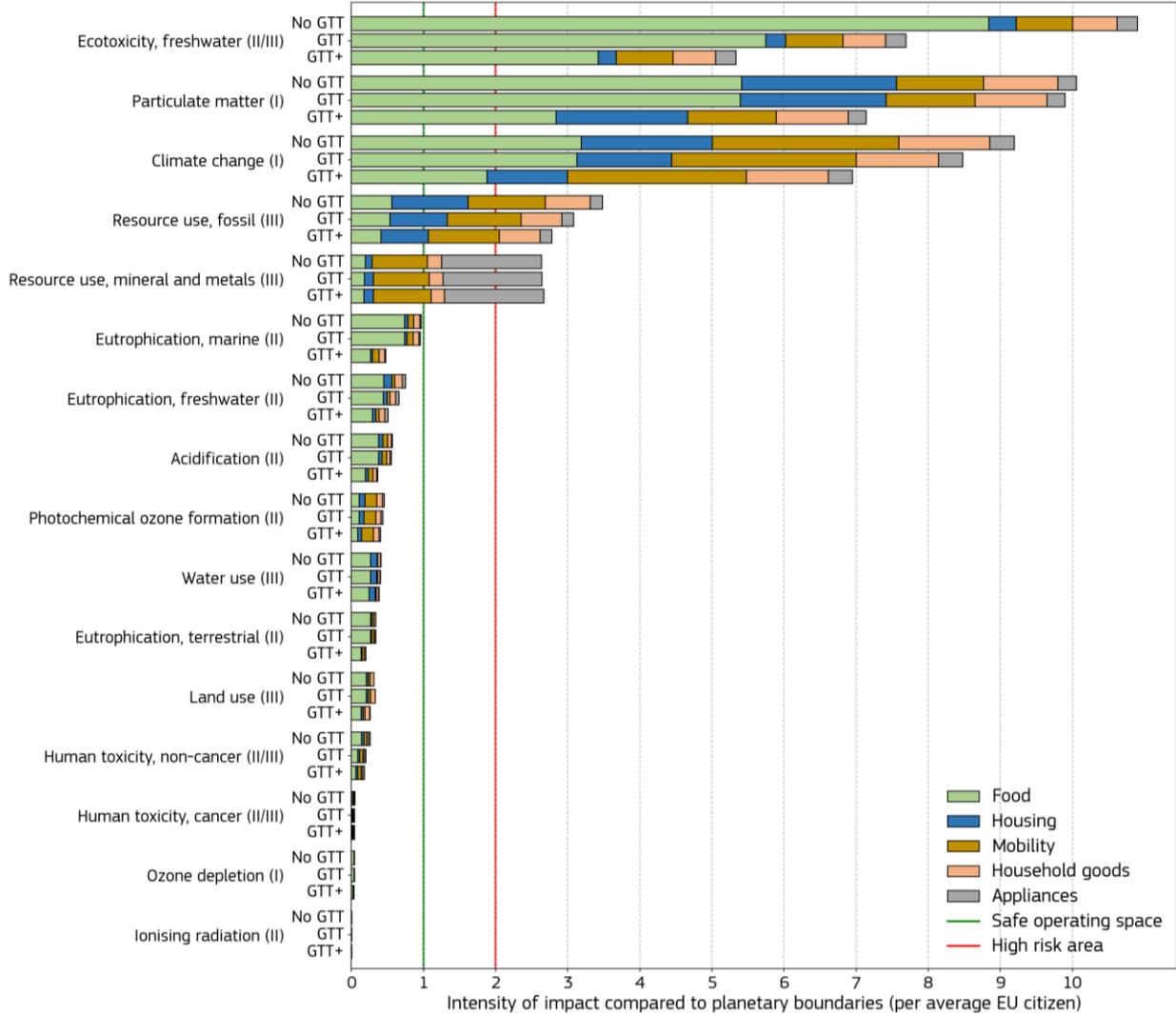
Figure 16. Consumption Footprint outlook compared to Planetary Boundaries.



Source: JRC elaboration.

The most important consideration is that **even if the EU were to achieve the selected GTT targets and ambitions** that are considered, EU consumption in 2030 would remain above the respective planetary boundaries for the same five categories already indicated as being above the planetary boundaries in 2022 (see also Figure 10 in section 4.1). However, more positively, the considered **GTT policies** show that, in contrast to the **NO GTT** scenario, the effort made reduces the environmental impact by between 30% (particulate matter, climate change) and 50% (ecotoxicity), compared to not implementing any policy changes (**No GTT**). Therefore, GTT measures are shown to be closing the gap between the current consumption footprint and the limits of the planet. **Areas which remain of major concern, and where most of the opportunity lies, are in the food and housing sectors**, as is explored in the following sections.

Figure 17. Contribution of every area of consumption to the Consumption Footprint outlook in 2030, showing results for No GTT, GTT and GTT+ scenarios compared to planetary boundaries.



Source: JRC elaboration.

6.3 Consumption Footprint Outlook by Area of Consumption

Figure 18 zooms in on the components of the total CF, by showing the existing trade-offs between the environmental impacts of the groups of products forming the overarching indicator. Figure 18 shows the percentage change of the environmental impacts for the three considered scenarios in 2030 compared to the historical value in 2022 (represented by the blue horizontal line, with the reference value of 100%). The **NO GTT** scenario shows increases in environmental impact for all impact categories for all product groups, while the **GTT** and **GTT+** scenarios show reductions across most impact categories, in particular for those which today are above planetary boundaries. These results are particularly visible in food, housing and mobility (as they also have specific green transition targets which have been modelled by targeting the emissions in those areas of consumption). However, such results are less visible in appliances, and household goods, for which no product-specific targets are considered in this exercise. Most importantly, the figure shows trade-offs between applying multiple policies, which were not visible at the aggregated level of the total CF proposed in the previous section.

In general, the areas of consumption where most of the improvement can be found are food and housing. However, these are **offset by the increased environmental impacts noted in mobility, appliances and household goods** across the scenarios. For example, looking at the gains and losses of the **GTT+** scenario for the impact category particulate matter, we find that the impacts of food and housing are reduced by -50% and -10%, respectively. However, these gains are offset by the increases in impact related to mobility (+18%), household goods (+8%) and appliances (+20%). The following section describes these effects in every area of consumption, separately.

Figure 18. Change in environmental impacts for the 16 EF impact categories by area of consumption for No GTT, GTT, and GTT+ scenarios in 2030 in comparison to historical data in 2022.



Source: JRC elaboration.

6.3.1 Area of consumption: food

Overview of the section:

- Food consumption is a major contributor to the EU Consumption Footprint, and is expected to remain stable unless green transition policy efforts are implemented. In the GTT scenario, in 2030 the reduction in use of pesticides by 50% reduces impacts with respect to 2022 by -2% to -37% for 12 of the impact categories.
- The GTT+ scenario shows reductions in environmental impacts for all EF impact categories in 2030 with respect to 2022. These are in the range of -3% (water use) up to -55% (terrestrial eutrophication).
- Moving to environmentally friendly diets proves to be the **most effective measure** to reduce impacts of the categories that are currently transgressing planetary boundaries⁶, up to -52% in eco-toxicity freshwater in comparison to 2022 values.

As observed in Figure 5 and Figure 10, the environmental impacts of **EU food consumption are responsible for many of the consumption-related transgressions of several planetary boundaries**. Without green transition efforts (top left in Figure 19, i.e., when comparing **No GTT** and observed data in **2022**), progress towards reducing these impacts would likely remain stagnant. This is mainly due to the stable population in the EU, which maintains the associated food consumption patterns stable. However, interventions are necessary across the entire supply chain to decrease the environmental impacts of the food sector, from promoting sustainable production methods to changes in consumer behaviour, as promoted by key policy measures within the Farm to Fork Strategy (EC 2020d), the Common Agricultural Policy (EC 2021c) and the Common Fisheries Policy (EC 2013).

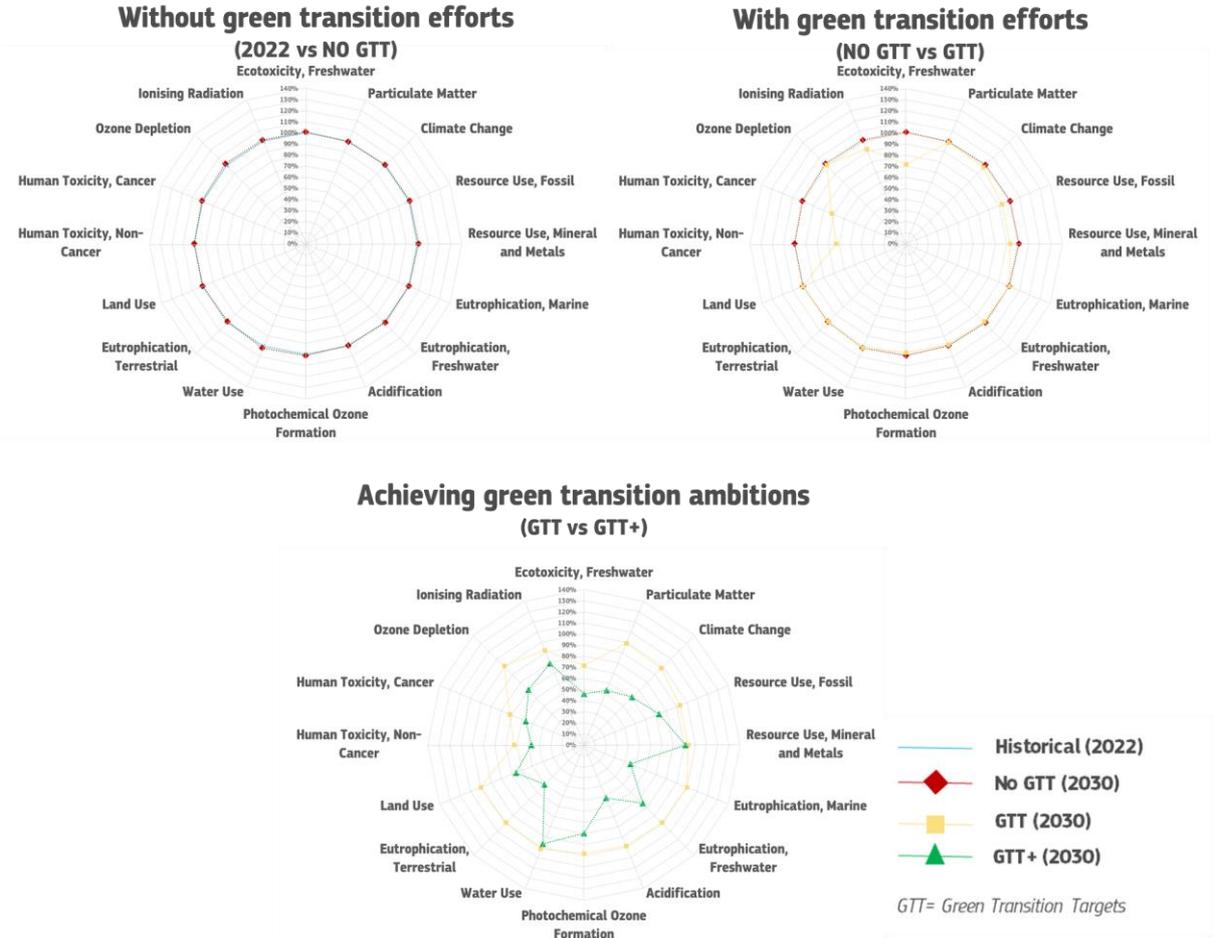
Reaching the different policy targets (see Table 3, Table 5) in the assessed scenarios will generally have a positive effect and reduce environmental impacts of the EU food consumption (top right quadrant in Figure 19). The assumed achievement in the reduction of pesticides by 50% in 2030 in the **GTT** is the major driver of the reduction in environmental impacts, with a strong expected focus on toxicity-related impacts (-32% in ecotoxicity, -30% in cancer, and -37% on non-cancer impact on humans compared to 2022). This is slightly supported by the achievement of cross-cutting targets, such as those supporting the expansion of cleaner energy (Table 5), related to which most impact categories reduce their impact by a few percentage points.

In the **GTT+** scenario (bottom in Figure 19), additional targets are assumed to be reached, such as decreasing the loss of nutrients, and the associated 20% decrease in the use of fertilisers leading to lower eutrophication to soil and water. In addition, the organic farm area should be increased by 25% and it is assumed that a transition to a healthier and more sustainable diet would be achieved. Compared to 2022, **impacts via the GTT+ scenario would reduce by 2030 all impact categories**, e.g., by **-3.5% (water use) to -55% (marine eutrophication)**. The implementation of several measures simultaneously would be imperative to significantly increase the sustainability of the food supply chain. This would then change consumption patterns to have associated impacts that were within the safe operating space for humanity, as well as decreasing those impacts where planetary boundaries have already been exceeded. According to the assessed targets, **following an**

⁶ The concept of planetary boundaries is valid only in the context of total Consumption Footprint (e.g., the sum of contribution to total environmental impact from every area of consumption). More details on how to account for planetary boundaries in the analysis are available in Section 9.

environmentally friendly diet⁷ would prove to be the most effective measure in reducing impacts (see further details in Section 7 and Annex 4).

Figure 19. Consumption Footprint outlook for the food area of consumption comparing the three scenarios in 2030 with historical data in 2022.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

⁷ The food diet scenario has been designed in line with Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., ... Murray, C. J. L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, 393(10170), 447–492. [https://doi.org/10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4).

6.3.2 Area of consumption: mobility

Overview of the section:

- Mobility is expected to increase its environmental impacts by 2030 if no green transition efforts are put in place. The **expansion of the stock of vehicles** assumed in the **NO GTT scenario** between 2022 and 2030 is the main driver of increased environmental impact across all EF impact categories.
- **Targets on sustainable biofuels show trade-offs** by reducing environmental impact in certain impact categories (e.g., climate change, fossil fuels resource use, freshwater eutrophication) while increasing others (e.g., land and water use).
- The **expansion of electric cars shows trade-offs between environmental impacts**, by decreasing impacts for four categories that are above planetary boundaries while resulting in increases in most of the other impacts, which do, however remain below the planetary boundaries⁸.

In 2022, the environmental impacts of **EU mobility had a significant contribution to the EU Consumption Footprint**, accounting for from **6% to 27% of the environmental impacts in the categories which transgress planetary boundaries** (Figure 10). Due to the assumed growth in the mobility sector (which is more intense compared to other areas of consumption such as housing and food), the overall contribution of mobility to the EU consumption footprint is assumed to increase further if no efforts in green transition are implemented (Figure 18).

The expansion of the stock of vehicles assumed in the **NO GTT** between 2022 and 2030 is the main driver of increased environmental impact across all impact categories, ranging from +15% in particulate matter and +20% in land use, but even more in freshwater eutrophication (+53%) and +56% in minerals and metals resource use.

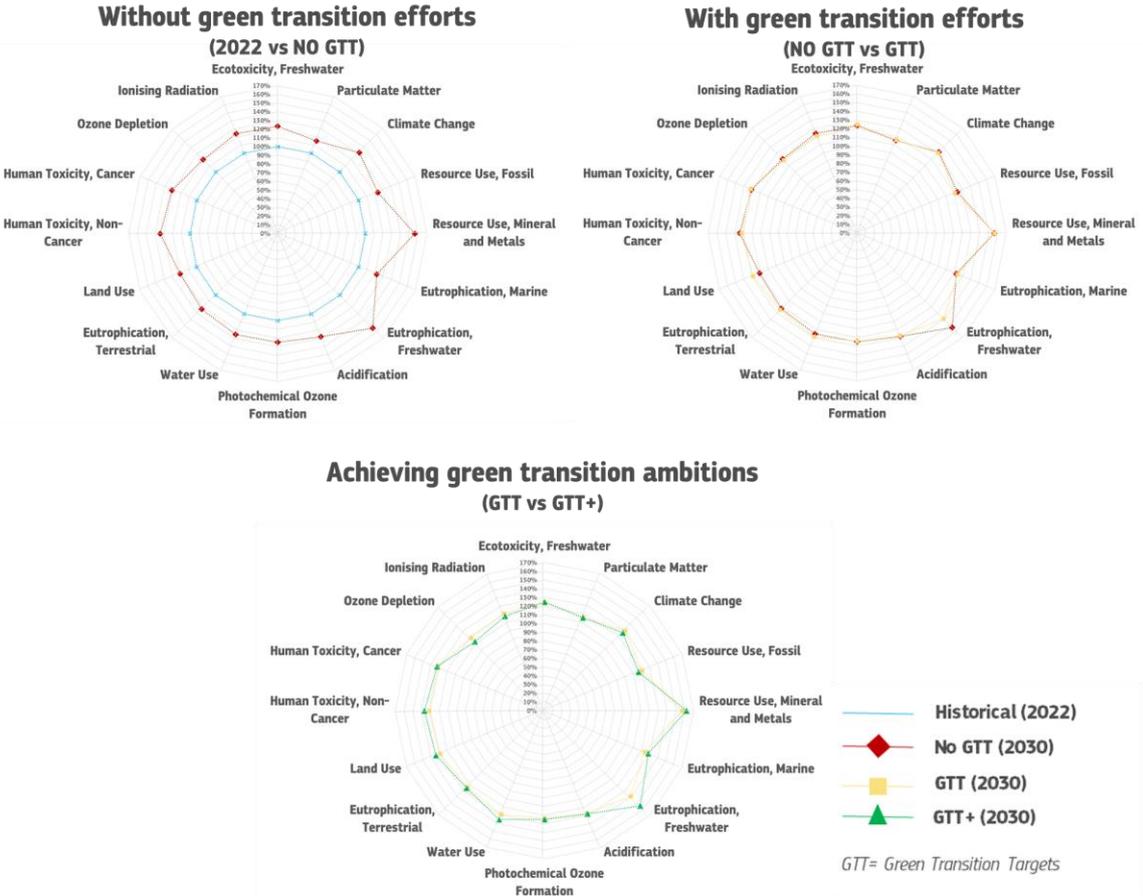
The achievement of the targets on sustainable biofuels and biogas in both road transport and aviation shows trade-offs. Environmental impacts in certain impact categories are reduced, while other categories increase (top right in Figure 20). More in detail, in the **GTT scenario**, the achievement of the considered sustainable biogas and biofuel targets, and targets linked to increasing the uptake of renewable energy sources, reduced impacts compared with **NO GTT** for fossil fuel resources use by -3% (+20% compared to 2022), climate change by -1% (+30% compared to 2022), and eutrophication in freshwater by -14% (+39% compared to 2022). On the other hand, compared with **NO GTT**, achieving these targets in the **GTT** contributes increasing other impacts, including land use by +8% (+28% compared to 2022) and water use by +3% (+29% compared to 2022) due to the production of fuels.

The **GTT+** scenario (Figure 20) shows that **the expansion of electric cars shows trade-offs between environmental impacts, via reducing the impact for four categories that are above planetary boundaries whilst increasing most of the other impacts**. Compared to **GTT**, the **GTT+ scenario** means that climate change is reduced by -4% (+30% compared to 2022) and fossil fuel resource use by -4% (+20% compared to 2022), and particulate matter is reduced by -1% (+16% compared to 2022) and freshwater ecotoxicity (+25% compared to 2022) are achieved.

⁸ The concept of planetary boundaries is valid only in the context of total Consumption Footprint (e.g., the sum of contribution to total environmental impact from every area of consumption). More details on how to account for planetary boundaries in the analysis are available in Section 9.

On the other hand, compared with **GTT**, **GTT+** means that the selected targets are found to increase the impact of the other impact categories including mineral resource use by +5% (+62% compared to 2022), land use by +5% (+33% compared to 2022) due to material in electric vehicles in the production phase and use of renewable resources for producing the electricity in the use phase. Despite increasing their impact, all categories that lie below planetary boundaries remain below the safe operating threshold, while environmental reductions are achieved in the categories that lie below planetary boundaries.

Figure 20. Consumption Footprint outlook of mobility comparing the three scenarios in 2030 with historical data from 2022.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

6.3.3 Area of consumption: housing

Overview of the section:

- Housing sector environmental impacts are expected to remain stable, even if no further policy efforts on green transition are pursued.
- Policy efforts considered in the **GTT scenario** provide significant reductions in environmental impacts (from -1% to -55% compared to 2022 data across different impact categories). This is largely due to the increase of the share in renewable energy sources in the energy mix. However, this comes at the expenses of increased use of mineral resources (+33% compared to 2022) due to the expansion of materials needed for solar energy panels, cables, batteries, inverters and infrastructure, etc.
- In the **GTT+ scenario**, achieving energy use reduction targets and renovation objectives by 2030 could reduce environmental impacts substantially compared to 2022 (e.g., by -60% for freshwater eutrophication). Most categories are reduced by from -40% (climate change and ecotoxicity freshwater) to -3% (land use). However, achieving GTT+ ambitions fully further increases the use of mineral resources by an additional +14% above GTT (by +48% compared to 2022).

As observed in Figure 10 the environmental impacts of EU housing in 2022 make a significant contribution to the CF aggregate environmental impacts. This is largely due to the housing use phase resource use (energy for heating and cooling, water use, etc.), contributing 33% of fossil fuel use and 21% of climate change, compared to the total impacts. No major changes are expected in the impact of housing in the **No GTT** scenario (top left, Figure 21). However, the analysis depicted in the **GTT** (top left in figure) shows the positive consequences of reaching the solar electricity expansion target in housing by 2030.

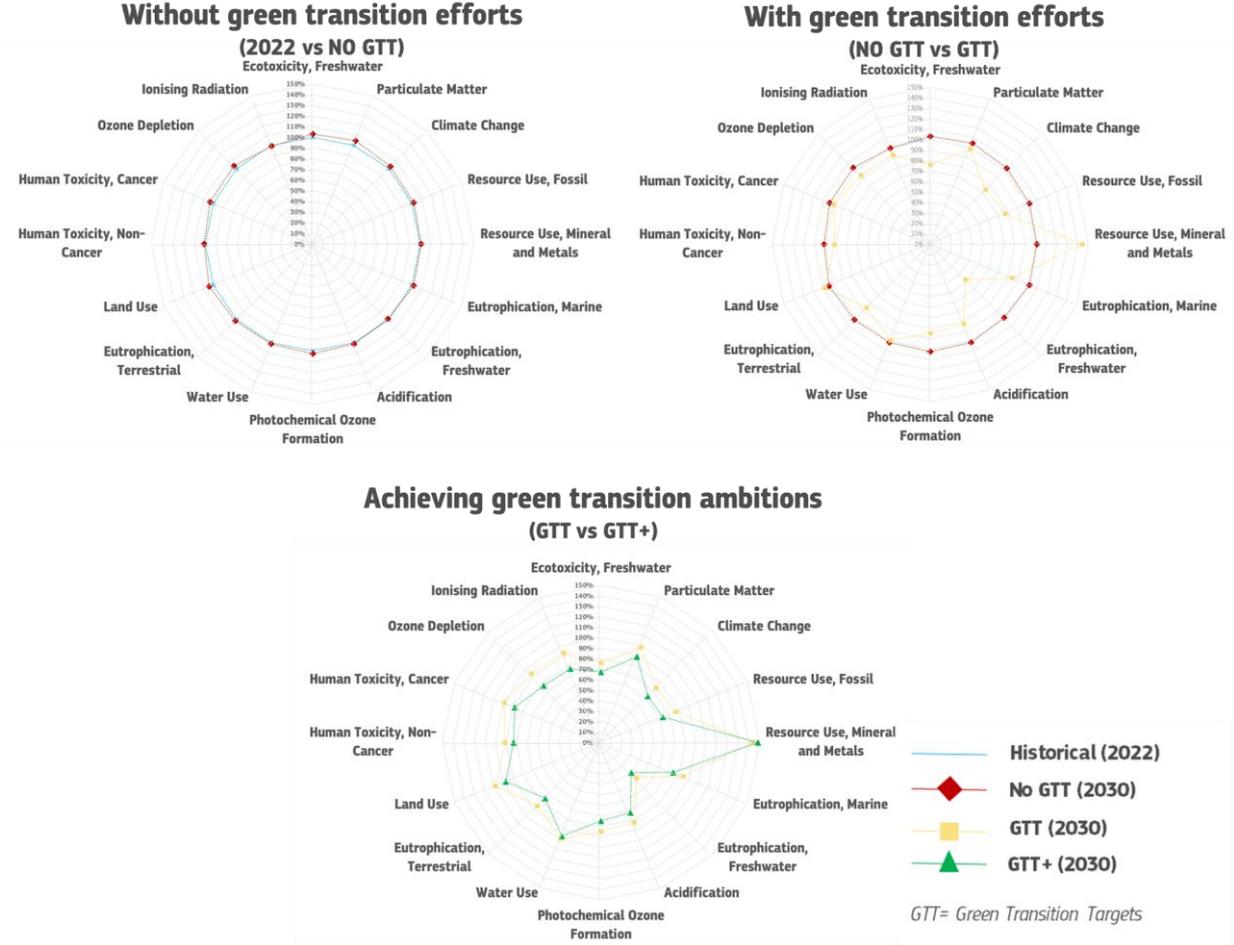
In the **GTT scenario**, the environmental impacts of housing in 2030 compared to 2022 results are significantly reduced across 14 impact categories. These range from a reduction of -0.5% (ozone depletion) up to the reduction of -56% (eutrophication freshwater). There are changes of -9% to -18% across four categories which transgress planetary boundaries. It should be noted that trade-offs are still expected: the vast expansion of solar in the energy mix would require an additional +33% of mineral resource use, but with only a small expansion of land use (+1% compared to 2022). It must still be emphasised that significant incentives and efforts would be needed to further improve the situation, as demonstrated by the achievement of the remaining targets on resource and energy efficiency, as well as targets on renovation.

The **GTT+ scenario**, the achievement of reduced energy and resource consumption in housing and constructing more efficient buildings (via the renovation wave) is expected to bring reductions of between -3% and -60% in environmental impacts for fourteen out of the sixteen impact categories, compared to 2022. Among those that transgress planetary boundaries⁹, significant changes occur in particulate matter (-11%), climate change (-37%), ecotoxicity freshwater (-33%) and fossil fuel resource use (-36%). Only land use (+18%) and mineral resource use (+47%) increase, due to the expansion of renewable resources in the energy mix, with associated input resource needs mainly related to the expansion of the electricity grid and to the increase of photovoltaic energy share within it. Trade-offs are inherent in the energy transition, and might originate namely from the

⁹ The concept of planetary boundaries is valid only in the context of total Consumption Footprint (e.g., the sum of contribution to total environmental impact from every area of consumption). More details on how to account for planetary boundaries in the analysis are available in Section 9.

associated higher commensurate quantities of mineral resources required in achieving this transition.

Figure 21. Consumption Footprint outlook of housing comparing the three scenarios in 2030 with historical data in 2022.



Source: Own elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

6.3.4 Area of consumption: appliances

Overview of the section:

- Without specific green transition efforts assessed in this exercise, the environmental impact of appliances in the **NO GTT** scenario is expected to rise considerably in 2030 compared to 2022, accounting for a +30% to +40% increased impact across all impact categories.
- The efforts of green transition policies, and in particular the expansion of renewable energy sources in the electricity mix and circular economy targets can significantly mitigate those rising impacts, including reducing impacts below 2022 levels. In the **GTT scenario**, environmental impacts in 2030 compared to 2022 data are reduced by -22% for eutrophication (freshwater), and climate change by -3%. However, the overall consumption footprint and all related environmental impacts show an increase, up to a maximum of +44% (land use). This is because of growth in consumption patterns from NO GTT, and partly linked to achieving energy transition targets (e.g., expansion of renewables in the energy mix).
- In the **GTT+ scenario**, the effects of recycling of plastic, coupled with the additional share of renewable sources in the energy mix show trade-offs between the impact categories. These result in reductions of -7% in climate change and -1% in fossil fuel use, but increases up to +36% in mineral resource use and +48% in land use, which are due to the increase in the transition to solar and wind energy sources.

In 2022, the **appliances** group of products accounted for a 53% share of all the mineral resource use footprint across all areas of consumption (Figure 10). Other shares of impacts related to the total footprint range from 3% (water use, and ecotoxicity-freshwater) up to 24% (ionising radiation), thus demonstrating the relative importance of this area of consumption.

Figure 22 shows that in the **No GTT scenario** (top left in figure) the environmental impact of appliances is expected to rise considerably in 2030 compared to 2022. Impacts across all categories increase by +30% to +40%. However, the **GTT scenario** (top right Figure 22) shows a major improvement against **No GTT**; compared to 2022, reduction of environmental impacts in crossing the planetary boundaries are -3% (climate change), due to the expansion of solar in the electricity mix, and a reduction of -22% in freshwater eutrophication (achieved via reaching the packaging recycling targets). This would be an important achievement, considering the assumption of a continued consumption growth up to 2030. However, the environmental impact is expected to be higher than in 2022 across all other impact categories, reaching +44% for land use (despite remaining below planetary boundaries), +34% in resource use minerals, +21% in particulate matter, and +19% in fossil fuel use (all of which had already transgressed planetary boundaries in 2022).

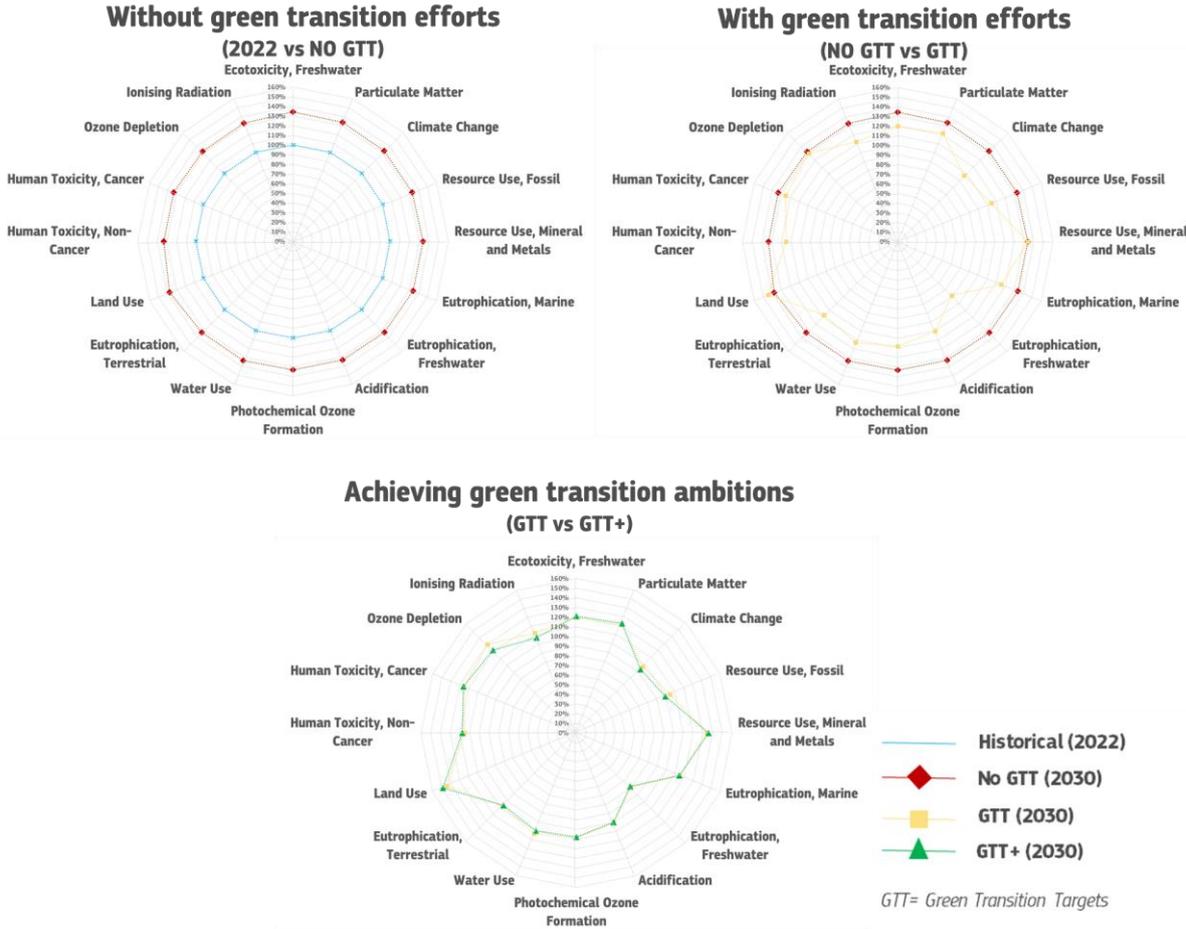
In the **GTT+ scenario, trade-offs are present, with ten impact categories being reduced compared to GTT, while six impact categories increase.** Environmental reductions are -4% for climate change compared to GTT (representing a -7% reduction from 2022), -5% in fossil fuel use compared to GTT (and -1% from 2022 values), and -8% (GTT+ vs. GTT) for ozone depletion, overall +21% compared to 2022).

However, reaching the GTT+ targets has trade-offs with increase in environmental impact for 5 categories; compared to 2022 these reach +48% for land use, +23% for particulate matter, and +36% in mineral resource use.

It should be noted that impact increases between **GTT** and **GTT+** scenarios related to human toxicity (both cancer and non-cancer), are often driven by the achievement of the landfill reduction target. This is because due to the CF modelling assumptions, reducing the landfill disposal rate

while keeping recycling rates constant has the effect of increasing the share of incineration of discarded material, with associated generation of more pollutants that impact health negatively. It is important to stress the fact that **the impacts of GTT+ compared to NO GTT (without green transition efforts) would reduce environmental impacts significantly across 14 impact categories. However, the GTT+ scenario increases land use (+14% compared to No GTT) and mineral resource use (+2% compared to No GTT), both related to higher renewables in the energy mix.**

Figure 22. Consumption Footprint outlook of appliances comparing the three scenarios in 2030 with historical data in 2022.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

Finally, it should be emphasised that in the definition of the green transition scenarios the selected targets do **not** consider individual consumer product-based policies. Product-level policies (e.g., setting energy use consumption limits for appliances via Ecodesign, Energy Labelling regulations, etc) were considered to be operationalised via their contributions to higher-level targets (e.g., overall energy reduction targets). In this respect, the 2024 Ecodesign for Sustainable Products Regulation (ESPR), will, over time, result in additional product-specific minimum and mandatory performance requirements for products to be placed on the EU market, thereby further reducing the impact per product. The ESPR also aims to expand the scope and build on the existing successful EU product policy framework on ecodesign and energy labelling/ energy efficiency, by further addressing horizontal measures linked to fostering a circular economy (e.g., durability) and addressing in addition non-energy-related products (e.g., textiles, furniture, etc).

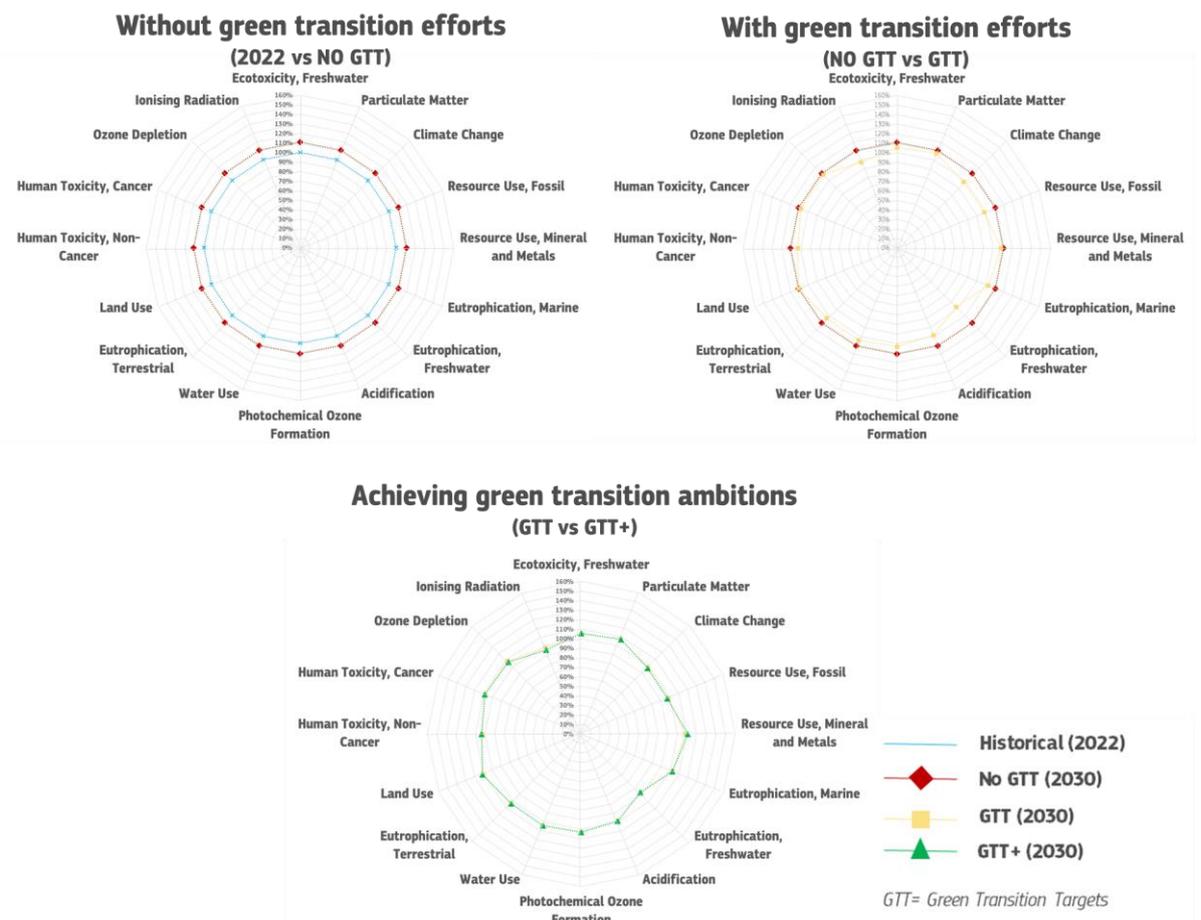
6.3.5 Area of consumption: household goods

Overview of the section:

- In the **NO GTT scenario**, a +10% increase in the environmental impact of household products is expected due to the assumed increased consumption of these products between 2022 and 2030.
- In the **GTT scenario**, environmental impact reductions across all EF impact categories are generated, but do not offset the increases due to consumption growth compared to 2022.
- In the **GTT+ scenario**, recycling of plastic and a higher share of renewable energy shows reductions in environmental impacts of up to -16% (freshwater eutrophication) compared to 2022 levels.

For those impact categories transgressing planetary boundaries in 2022 (see Figure 10), household goods accounted for shares of the total environmental impacts between 6% (ecotoxicity freshwater) up to 22% (fossil fuel resource use), and spanned 9% to 24% across other impact categories, thus showing the significance of the housing goods sector for the overall consumption footprint.

Figure 23. Consumption Footprint outlook of household goods comparing the three scenarios in 2030 with historical data in 2022.



Source: JRC elaboration. The figure compares scenarios to highlight three key messages: without green transition efforts (2022 vs NO GTT), with green transition efforts (No GTT vs GTT), and achieving green transition ambitions (GTT vs GTT+).

These impacts are expected to increase by about 10% across all EF impact categories due to the assumed continued growth in consumption patterns. Similarly to appliances (see section above), no specific targets at the product level for household goods were included in the analysis. However, the **GTT scenario** (top right in **Error! Reference source not found.**) shows how **green transition efforts reduce environmental impacts across all EF impact categories, but are offset by consumption growth** compared to 2022. 14 out of 16 impact categories are expected to increase from 2022-2030 (to +9% for ozone depletion). At the same time, the assumption of reaching targets on packaging recycling reduces the consumption footprint for freshwater eutrophication by -11%, ionizing radiation by -2%, despite consumption growth up to 2030. The achievement of **GTT+** targets shows **limited impact**.

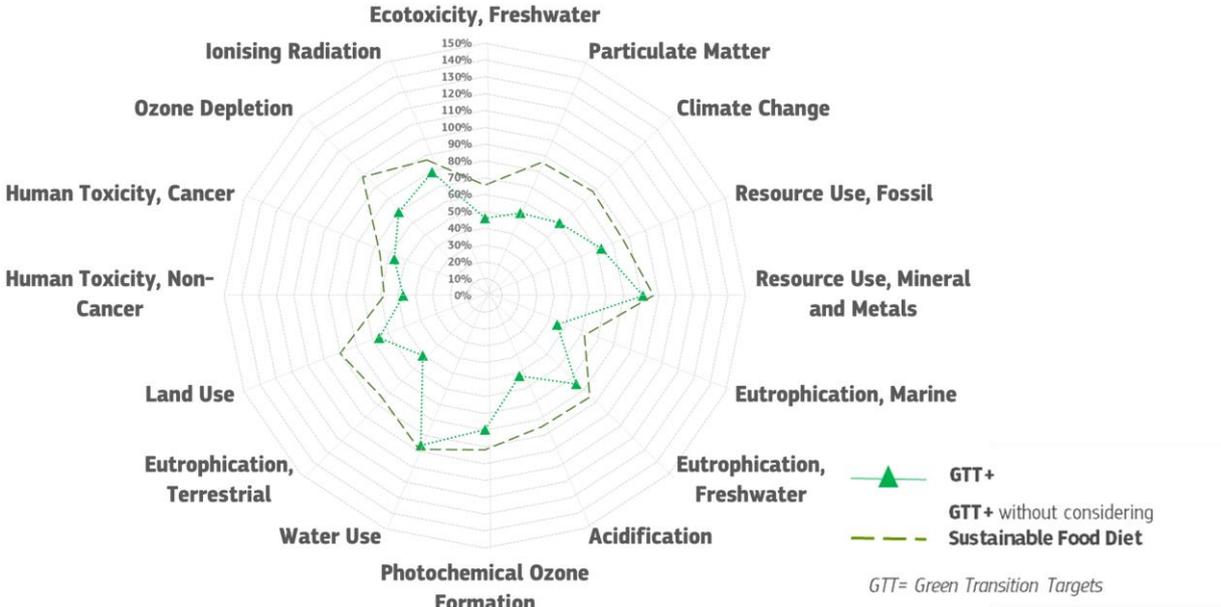
7 Consumption Footprint Outlook: zooming into specific scenarios

7.1 Zoom-in: Shift towards a more sustainable and healthy diet

Figure 24 presents the relative changes in environmental impacts of the CF for the food sector for the **GTT+ scenario**, and highlights the possible impact of diet change in 2030 by comparing it with the ‘**GTT+ without considering the Sustainable Food Diet scenario**’.

For this exercise, we use the proposed dietary change from average EU consumption as indicated in Willett et al. (2019), and described in Annex 4 of this report. The **GTT+ scenario** shows the benefits of substituting the consumption of large amounts of livestock and dairy products with protein rich vegetables such as legumes, and substantially increases in the consumption of fruits and vegetables. The GTT+ interventions already show the substantial benefits of green transition policies compared to 2022 (mainly driven by reduction in use of pesticides, decreased use of fertilizers, and expansion of organic farming). Results include decreased impacts of -1% to -42% across all impact categories, with climate change, particulate matter and freshwater ecotoxicity recording impact reductions of -12%, -14% and -34%, respectively. The **inclusion of a sustainable diet** amplifies the trend considerably. Compared to 2022, the impacts that have transgressed planetary boundaries can be reduced by -39% (climate change), -54% (freshwater ecotoxicity) and -47% (particulate matter). It should also be noted that via the sustainable diet scenario, the safe operating space for these impacts would not be reached until 2050.

Figure 24. Effect of move towards a more sustainable and healthy food diet and comparison with GTT+ scenario.



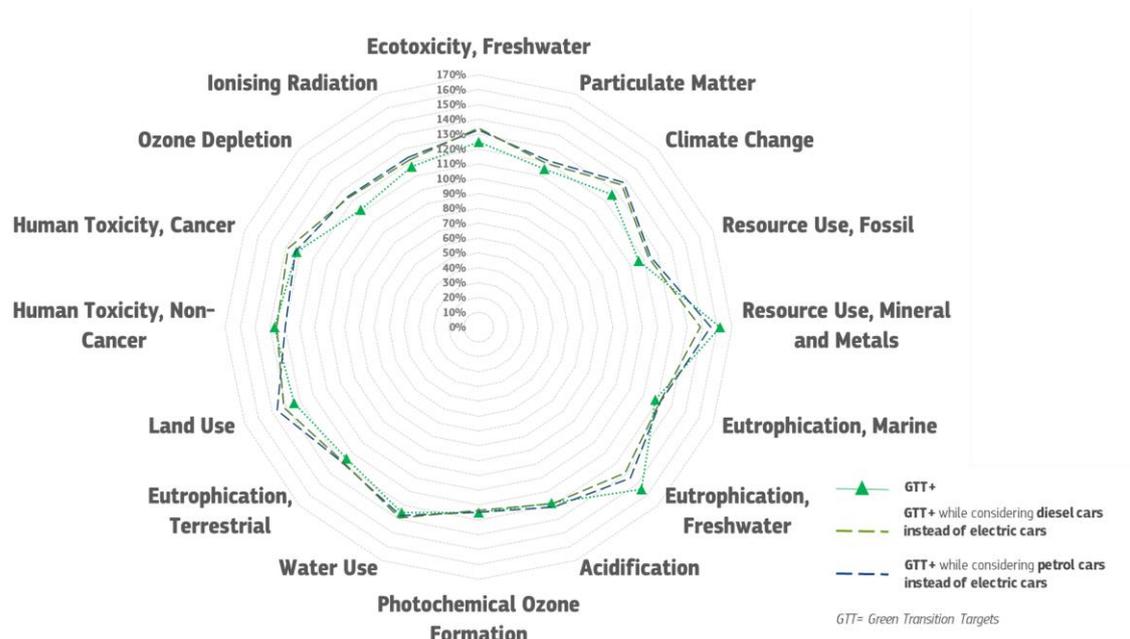
Source: JRC elaboration.

7.2 Zoom-in: Expansion of electric cars on the road

The main driver of the difference between the **GTT** and the **GTT+** scenarios in Figure 20 is largely dependent on the assumption of the target of placing 30 million electric road vehicles on the EU market, substituting the equivalent number of Euro 6 Diesel and Petrol cars by 2030. To show this difference, Figure 25 shows the equivalent of the **GTT+** scenario in 2030, whereby the additional electric cars between the **GTT** and **GTT+** (assumed to be an additional 18 million cars) could be substituted by petrol cars. There are two simulations: (i) '**GTT+ while considering petrol instead of electric cars**' scenario (dark blue in figure); and (ii) diesel ('**GTT+ while considering diesel instead of electric cars**' (dark green in figure).

Both scenarios use the Euro 6 cars level of technology for the diesel/ petrol Internal Combustion IC cars, thus comparing the electric vehicles to the most efficient IC technologies available on the EU market.

Figure 25. Effect of achieving 30 million electric cars on the road and comparison with GTT+.



Source: JRC elaboration.

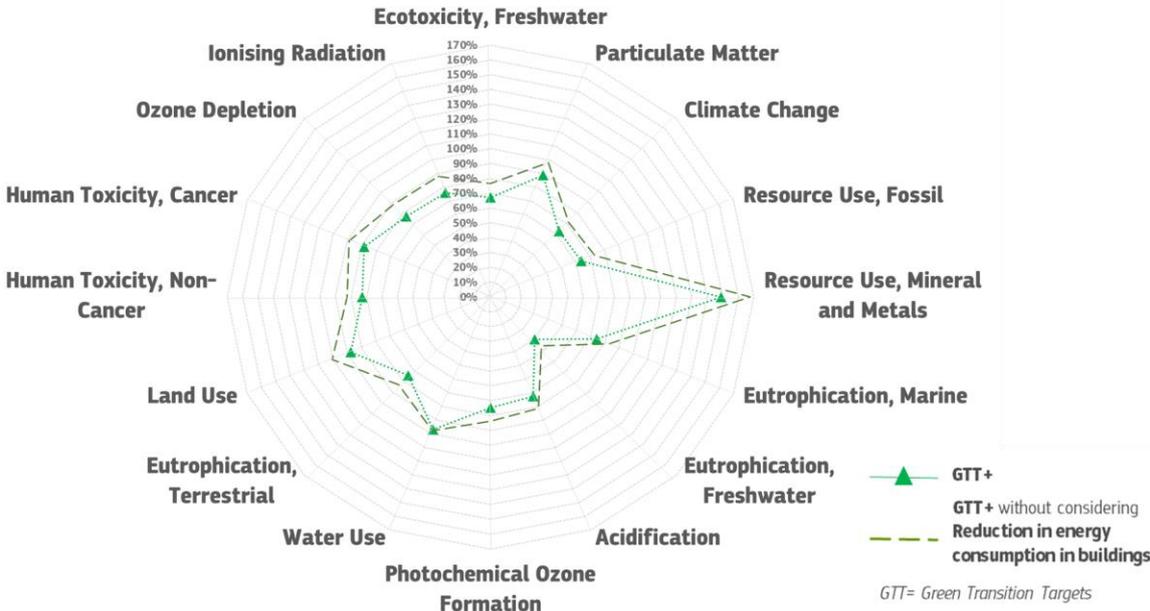
By focusing on the impact categories that lie above planetary boundaries, the results indicate that **GTT+** provides a potential reduction in several impact categories, i.e., in particulate matter (-6% against petrol and -4% against diesel), climate change (-11% against petrol and -9% against diesel), freshwater ecotoxicity (-8% against petrol, and -7% against diesel). On the other hand, the transition to electric vehicles shows an increase in mineral resource use (+7% against petrol, and +14% against diesel), and an increase for three toxicity-related impact categories from +1% to +16% in terms of freshwater eutrophication, non-cancer human toxicity, and photochemical ozone formation., respectively. This indicates the existence of important trade-offs in environmental impact in achieving this vehicles market penetration target. It is worth noting that all the above scenarios assume that the EU energy mix for electricity production is still largely based on fossil fuels; thus, the performance of this target is also dependent on the achievement of energy transition targets. If additional renewables were included in the energy mix, the reduction in environmental impact due to the expansion of electric cars in the systems would be larger.

The current popularity of electric vehicles and the declining costs of batteries may generate tipping points in the expansion of the electric vehicle market. However, this might in turn lead to significant rebound effects, thus increasing sales and thus overall car populations further. However, this is also very much related to price, and electric vehicles are still sold at a premium compared to conventional (IC) technologies. The important conclusion from our study is that the possible expansion of electric vehicles may not necessarily generate a win-win situation across different environmental sustainability objectives; instead, it rather adds up to weighing up trade-offs, while possibly increasing various impact categories. However, an expansion in the share of electric vehicles in the overall vehicles market at the expense of petrol and diesel cars could help to reduce impacts across the several impact categories that transgress planetary boundaries, thus generally supporting the achievement of green transition targets in the EU.

7.3 Zoom-in: energy efficiency in buildings

Figure 26 highlights the possible impact of reaching the targets linked to energy reduction in the **GTT+ scenario** by proposing a '**GTT+ without considering reduction in energy consumption in buildings**' (dark green) scenario. The targets implies reducing the final energy consumption by 14% and reducing energy consumption from heating and cooling by 18% compared to the year 2015 (base year for target implementation). This can be achieved by making buildings more energy efficient and less carbon intensive, over the full life cycle and by applying circularity principles to renovate buildings.

Figure 26. Effect of achieving the energy consumption reduction targets in buildings and comparison with GTT+



Source: JRC elaboration.

The corresponding gap consists in the reduction of environmental impacts across all impact categories. Compared to **GTT+**, this corresponds to reductions of between -8% and -12% across the entire life cycle for thirteen out of the sixteen impact categories, and even -18% for mineral resource use. This indicates how policies that influence the use phase of housing represent the key hotspot for concentrating efforts in policy-making. Reducing energy demand (via retrofitting best insulation practices, and modern designs for new-build) and reducing emissions from heating and cooling systems over time, give the best progress towards returning to within the planetary boundaries.

It is worth noting that **behavioural change** can play an important role in the achievement of this target. While effective policy-making can reduce energy consumption in buildings, this could rebound due to perceived lower consumption; thus, citizens might set their heating systems to warm up houses more, or vice versa with air conditioning in the summer. Additional behavioural incentives and information may help to sensitise EU citizens to reduce demand, while exploiting the full benefit of more efficient buildings.

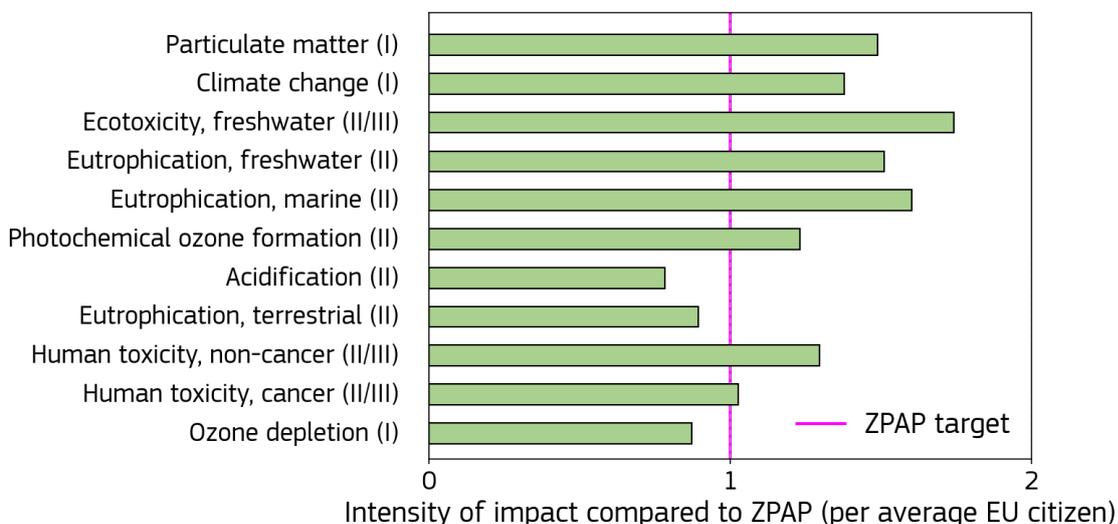
8 A focus on the Zero Pollution Action Plan

8.1 Reference condition and ZPAP targets

The ZPAP targets are defined as reduction targets in comparison to the past performance of EU policies governing emissions to the environment. Considering that the DF and CF models are based on different approaches, the ZPAP targets have been adjusted to reflect their structure separately. For example, to calculate the value of the target of a 55% reduction in the health impacts of air pollution from the year 2005, the recorded values of the DF and the CF for particulate matter and photochemical ozone formation (i.e., the categories influencing air pollutants) in 2005 were reduced by 55%, leading to two different target values per se (one per model). It is worth noting that the scope of ZPAP targets is exclusively domestic for the EU territory (which is aligned with the DF model), while the CF model scope also includes the impacts from imports to the EU. As a result, the application of ZPAP targets on the CF model outlines the need to work on including consumption targets to address the gap between domestic and consumption trends that are observed in both historical data and the outlook. Details for all calculations are available in Annex 5 and Annex 6.

Figure 27 and Figure 28 show the state of the EU's environmental impacts for the DF and the CF compared to ZPAP targets in 2022, whilst highlighting the categories that transgress the planetary boundary thresholds.

Figure 27. Domestic Footprint in 2022 compared to Zero Pollution Action Plan targets

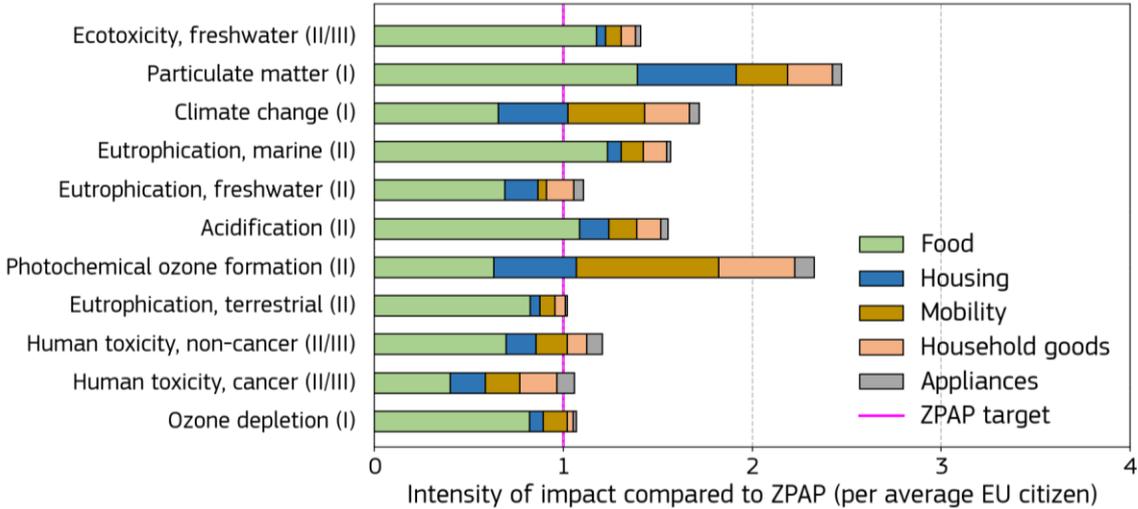


Source: JRC elaboration

For the DF, Figure 27 shows that the ZPAP targets for 2030 were already achieved in 2022 for three out of the 11 impact categories considered, namely acidification (-22% of ZPAP), ozone depletion (-22% of ZPAP) and terrestrial eutrophication (-11% of ZPAP). More needs to be done by 2030 with respect to the other categories, which are shown as increasing rather than decreasing. Particular attention needs to be paid to particulate matter (+49% compared to ZPAP) and climate change (+12% compared to ZPAP); these two impact categories are already well above planetary boundaries (e.g., 12 times for particulate matter, and 7 times for climate change).

Figure 28 shows that, when including imports via the use of the CF model, the situation becomes less favourable, since all the impact categories considered do not meet the ZPAP targets. In addition, the categories that are well above planetary boundaries remain far from achieving the target in 2022, with +147% for particulate matter, +40% for freshwater ecotoxicity, and +39% for climate change. It is worth noting that food represents the vast majority of impacts, alone being responsible for transgressing ZPAP targets for three impact categories (freshwater ecotoxicity, particulate matter, and acidification).

Figure 28. Consumption Footprint in 2022 compared to Zero Pollution Action plan targets in 2022



Source: JRC elaboration

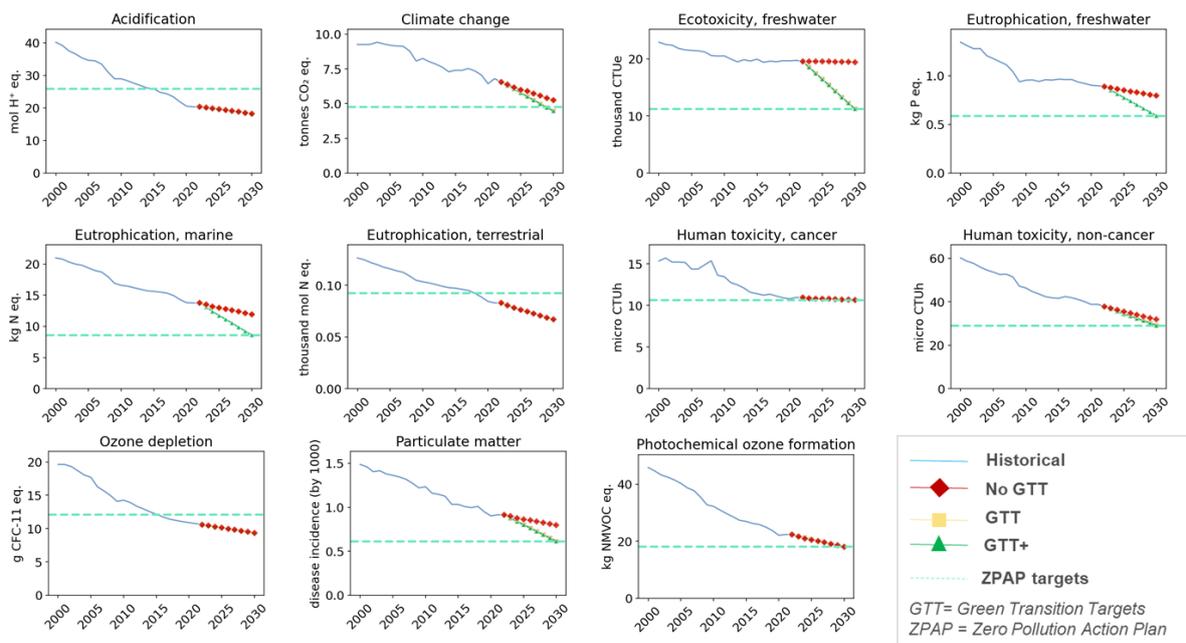
8.2 Domestic Footprint Outlook and Zero Pollution Action Plan targets

Figure 29 compares the DF-adjusted Zero Pollution Action Plan (ZPAP) targets with DF historical trends, and the three outlook scenarios to 2030. Following the historical trends in environmental impacts, the **No GTT** scenario is assumed to meet six targets out of 11. In addition to those already met in 2022 (i.e., acidification, terrestrial eutrophication, and ozone depletion), the **NO GTT** scenario meets the 2030 targets for climate, human toxicity cancer and photochemical ozone formation.

The **GTT** scenario, which assumes the achievement of the target on 50% pesticides reduction, and 55% reduction in health impact due to air pollution, also contributes to reduce freshwater ecotoxicity, particulate matter and human toxicity non-cancer to the point of meeting the target. It is worth noting the abrupt reduction in the trend towards the achievement of the target in 2030, giving a sense of the policy challenge ahead to change the pathway towards zero pollution.

The **GTT+** scenario, when compared with the other scenarios, also shows a further improvement in the categories of marine eutrophication and particulate matter, actually enabling the targets set for 2030 to be achieved. These extra improvements shows that this additional effort is worth it, in order to reduce pollution to levels that are healthier and more sustainable for EU citizens.

Figure 29. Domestic Footprint outlook and ZPAP targets.

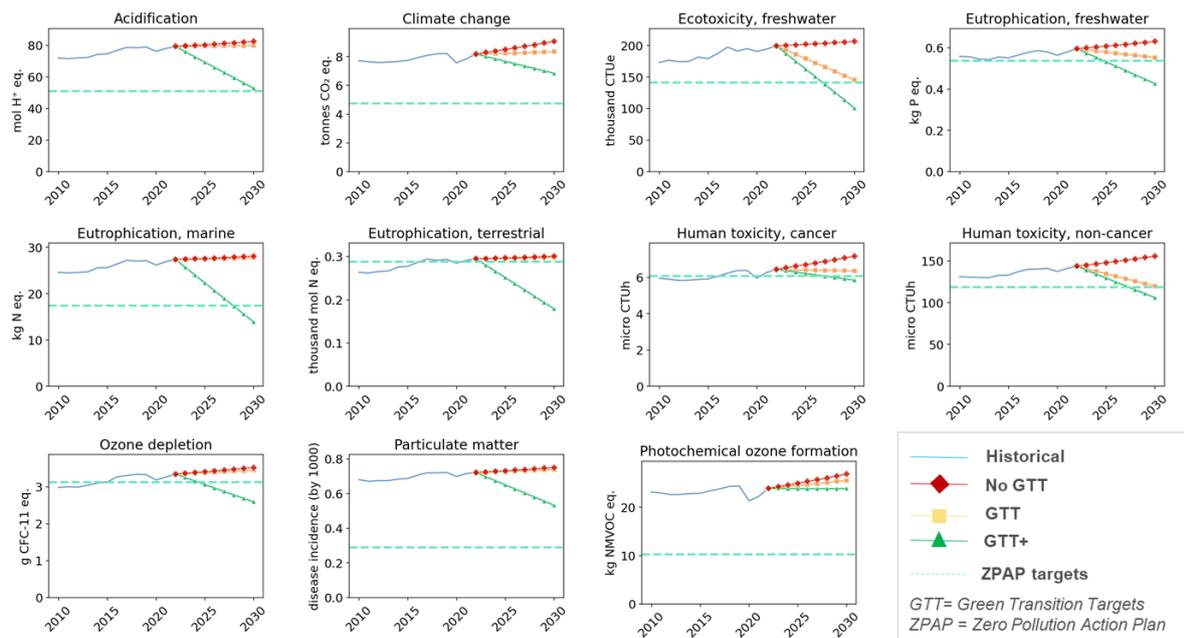


Source: JRC elaboration.

8.3 Consumption Footprint Outlook and Zero Pollution Action Plan targets

In contrast to the DF, the CF is driven by growing consumption (much of it derived from product imports from third countries). As a result, the **No GTT** scenario, subject to increasing consumption growth, points to the need to push the decoupling of associated pollution and resource use from potential consumption growth, where possible, via influencing policy parameters governing the LCA composition of products (see Figure 30).

Figure 30. Consumption Footprint outlook compared to ZPAP targets.



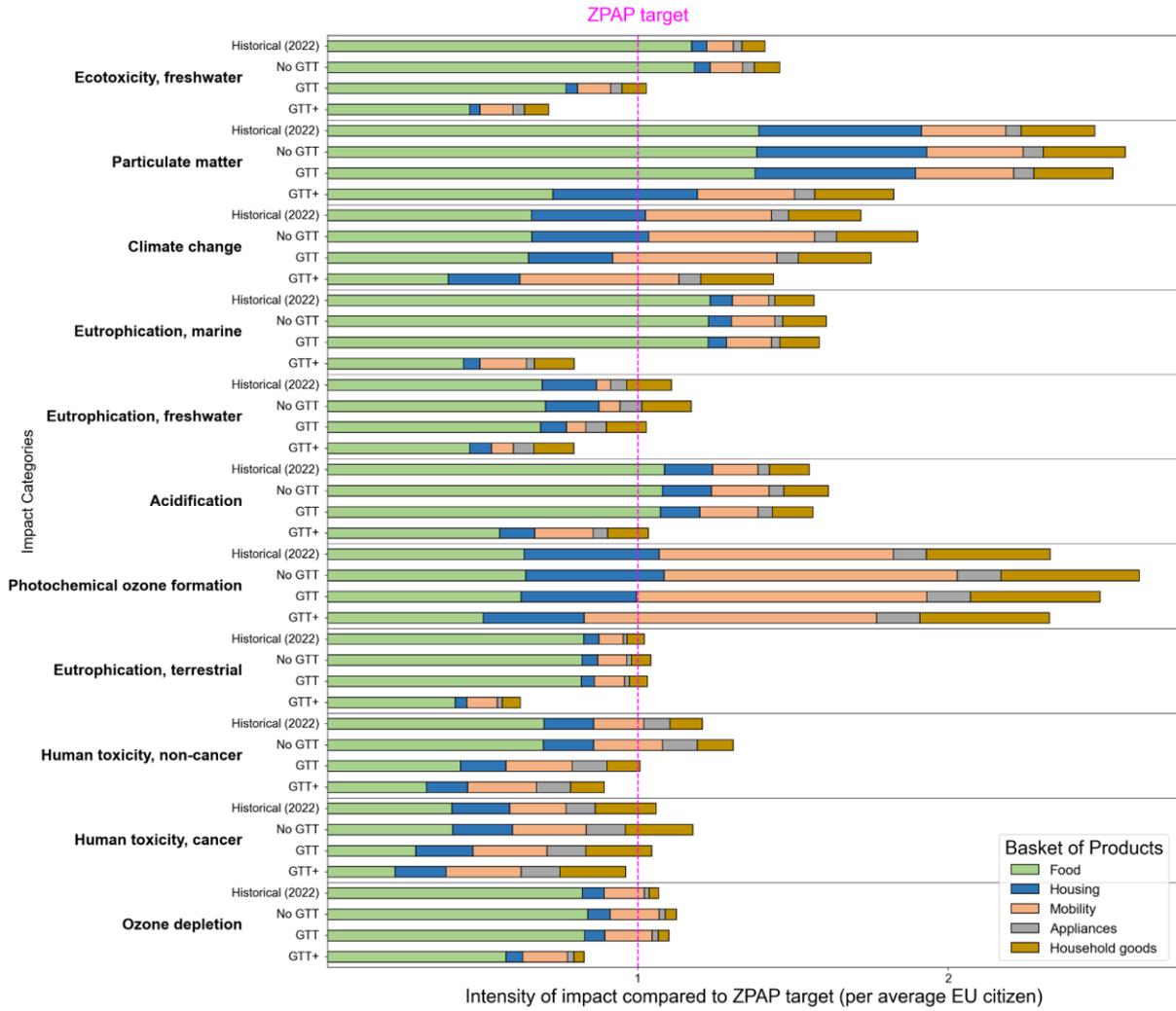
Source: Own elaboration.

In the **GTT** scenario, two impact categories are expected to decrease and reach the ZPAP targets (non-cancer human toxicity, and freshwater ecotoxicity). This is mostly due to the achievement of energy transition targets by increasing solar energy in the energy mix, and assuming the achievement of target indicating a reduction in the use of pesticides.

The additional ambitions in the **GTT+** scenario show that modelled environmental impacts are further reduced even below ZPAP targets. This is particularly due to the successful full implementation of the policy measures associated with the Renovation Wave (in housing), and dietary changes in food, where the EU population is assumed to move progressively towards a more sustainable consumption patterns. For example, it is estimated that the benefits of sustainable and healthy diets would decrease impacts across the 16 environmental impact categories by 1% to 42%, with climate change, particulate matter and freshwater ecotoxicity impact reductions of 12%, 14% and 34%, respectively.

By disaggregating impacts into areas of consumption (see Figure 31), it is possible to see those product groups which influence pollution more than others. This also shows the large potential of the food sector, and the associated opportunities that could be gained from more progressive, sustainable agricultural policy to reduce pollution.

Figure 31. Consumption Footprint outlook to 2030 compared to ZPAP targets, highlighting the contributions of each area of consumption.



Source: JRC elaboration.

8.4 Results of comparison with ZPAP targets

This study reveals the following principal trends and observations:

- Current trends in EU consumption patterns would perpetuate an increasing trend of most environmental impacts of EU consumption, which unfortunately transgress planetary boundaries for many environmental aspects.
- EU consumption is a driver of significant pollution through the production systems that operate within the EU and in third countries - via imports - to meet the EU demand for goods and services.
- While the EU Domestic Footprint shows a continued decrease in most impact categories, key Planetary Boundaries are also transgressed (e.g., climate change, particulate matter).
- **Food, housing, and mobility are responsible for more than 80% of the total aggregated environmental impacts.** Therefore, to meet the ZPAP overarching objective of living within planetary boundaries, measures to reduce total product/ service demand would be needed, with a primary focus on these consumption domains and their associated production and supply chains.
- The Green Transition Targets (GTT) scenario and the GTT+ (ambitious, including voluntary measures) scenario both show positive effects, if they were to reach fruition and full implementation, compared to the No GTT scenario. However, further efforts are needed. The green policy initiatives included in the GTT scenario should make progress by 2030, but extra initiatives going beyond the legislative minimum requirements of the green transition (the “GTT+” measures) are necessary to reduce environmental impacts down to the ZPAP 2030 targets for several toxicity and eutrophication impact categories. ZPAP 2030 targets for ozone depletion potential, photochemical ozone formation and particulate matter exceed planetary boundaries in 2030, **even with the green transition ambitious scenario.**
- By 2030, even if all GTT ambitions were to be achieved, the environmental impacts of EU consumption are expected to remain above the “safe operating space” of planetary boundaries for particulate matter, freshwater ecotoxicity and climate change by factor of five times to eight times. However, the overall positive effect on the environmental impacts highlights that the direction of fulfilled GTT scenario targets would be adequate, but still insufficient. This modelled result highlights the need for further implementing efforts to enable accelerated progress in achieving EU sustainability policy targets.
- Specific trade-offs were observed for particular environmental aspects (e.g., minerals and metals resource use) and areas of consumption (e.g., increasing consumption trends in appliances and household goods). The circular economy must be harnessed to a greater degree, to play a key role in reducing the total demand for materials and use of resources. This can be achieved on the production side via further optimising actions that are already being partly deployed, e.g., using resources efficiently, especially reducing the amount of virgin resources per product output).

- On the consumption side, existing policy measures for products should be further ramped up where feasible, including the encouragement of less consumption where this is possible. Such measures include facilitating, for example, better and easier repair and maintenance of products, coupled with behavioural actions targeting better consumption patterns. Also, it is important to build on established circular economy actions contained in Ecodesign regulations and associated horizontal actions, to be further addressed in the future implementation measures associated with the 2024 Ecodesign for Sustainable Products Regulation (ESPR) and the 2024 Right to Repair Directive. From a housing perspective, the implementation of the revised 2024 Energy Performance of Buildings Directive and the associated Renovation Wave measures will represent important advances.

9 Limitations of this study

This study presents a number of limitations that have to be taken into consideration when interpreting the results.

First of all, the methodology uses a **life cycle assessment approach**, that is, it focuses on **environmental impacts** without considering possible feedback interactions with the economic, social, and natural resources constraint domains. As a result, the scenarios proposed are to be interpreted as an assessment of what environmental impacts could be, under selected assumptions. As explained, only a selected limited number of policy targets have been represented in the Consumption Footprint and Domestic Footprint Outlook modelling exercises, which rely on existing studies to make forward projections of the annual consumption of products in the future and expert judgement to understand to which level the targets might be reached (see Section 3). As a result, the study proposed should be considered as an illustrative analysis of selected targets, including those contained within the Zero Pollution Action Plan and as examined in the “outlook” component of the associated *Zero Pollution Monitoring and Outlook Report* (see EEA-JRC, 2025).

In addition, the models do not consider potential supply-demand adjustments, nor do they provide specific indications on how policy-makers might adapt their strategies in order to have greater confidence that the targets and ambitions should be met. For example, a policy linked to the expansion of electric cars (enhanced market penetration) in the EU car fleet might cause a price change in the raw materials that are required to manufacture such vehicles; these perturbations and their potential supply-demand consequences are beyond the scope of our analysis. Similarly, potential resource constraints, including those resulting from potential competing resource uses, are not taken into account (i.e., whether the EU/ its suppliers will have ready access to the fossil fuel, other mineral or material resources, or the competing land and biomass uses). Further analyses via other methods and models would be needed to complement and build on the current analyses – using the Domestic and Consumption Footprint models – to provide further insights in this respect.

Secondly, specific **product-related targets** for the appliances and household good areas of consumption of the Consumption Footprint model are not considered. For example, the study does not consider the advances to date of Ecodesign and Energy Labelling regulations for appliances (EC 2022b). However, product-related targets usually contribute to sector-level targets, which are considered in the assessment. As a result, the modelling of energy reduction targets in the housing areas of consumption (which entails the reduction in energy consumption of single appliances¹⁰) may be considered as to support an estimate of the improvement in energy efficiency in these appliances, and associated reduction in their environmental impact.

Thirdly, **rebound effects** considerations were not taken into account (see, for example, Guzzo et al. (2025), EC-JRC (2024c)). For example, the achievement of policy targets which may lead to reduction in consumption patterns, such as lowering energy use in buildings, or more efficient cars, may result in economic gains for consumers over time (via lower bills). However, these same consumers may decide to increase the use of such products (e.g., drive their car more, or use household heating at slightly higher temperatures or over longer durations, etc.), or spend the

¹⁰ For considerations on how to correctly consider double-counting of environmental impacts between different areas of consumption in the Consumption Footprint model, see Annex 8 in Sanyé-Mengual et al. (2025) and Sanyé-Mengual et al. (2023a).

money saved on buying additional related or unrelated products, etc. This may have the net effect of increasing energy/ resource demand, thus potentially offsetting the positive results of the policy-related innovation and efficiency gains. It is worth noting that the study assumes that economic growth will continue to lead to increased consumption growth over the time frame of the analysis (between 2022 and 2030), and that the predictions used are based on past trends. In the scenarios analysed, if rebound effects were estimated and included, this might result in increased environmental impacts, overall. By correlation, the scenarios proposed in this study might be over-optimistic with regard to future environmental impacts.

Fourthly, when comparing the results of this assessment with **planetary boundaries** (PB), it should be noted that different methods are available for the calculation of the PB, which may also generate different results (Paulillo and Sanyé-Mengual 2024). Note that the method adopted for calculating PBs in this study relies on the Consumption Footprint-related methodology as proposed in Sanyé-Mengual et al. (2023a). Second, it should be noted that the use of PB represents an absolute framework by which to compare the environmental impact of the consumption associated with an average EU citizen with a sustainable lifestyle, in which the impact of each citizen respects the global environmental limits. In so doing, the assumption at the basis of this calculation is egalitarian, in the sense that a global PB is calculated based on the total population of the planet, and assumes that every person would be allotted the same share of permissible impacts for Earth to stay within a safe operating space. However, alternative allocation methods can be employed (e.g., allocating PB according to countries that have historically had more impacts, or according to income) (Paulillo and Sanyé-Mengual 2024).

Fifthly, similarly to the context of PBs, the **thresholds used** to calculate the Zero Pollution Action Plan targets in the models of the Domestic Footprint (see Annex 5) and Consumption Footprint (see Annex 6), are calculated based on the historical values which underpin these models. As a result, the ZPAP thresholds proposed in this study (see Sections 8, Annex 5 and Annex 6) are strictly only fully relevant when taken in the context of these models, and are not directly translatable to other policy-relevant applications that do not use the CF and DF simulations.

Finally, it can be noted that **LCA models and methods**, including the Commission recommended Environmental Footprint method itself, are under continuous revision and development, striving for constant improvement and taking into account recent academic and applied work. For a number of environmental impacts (e.g., biodiversity loss, microplastics), cutting-edge impact assessment methods are still under development by practitioners and are being refined by the international LCA community (see Garcia-Herrero et al. (in preparation)).

Despite the above limitations, the report still provides sufficiently robust overall evidence of how EU policy is currently making good progress in the context of delivering a more sustainable future. The report also underlines that the effort made so far could readily be built upon, via additional measures, to attain a prosperous and sustainable future for EU citizens, that is within our grasp within the medium term.

10 Conclusions

The **EU's environmental impact is decreasing within EU borders**, as measured by the Domestic Footprint, showing absolute decoupling over time of environmental impact and pressures from economic growth. However, the environmental impacts from consumption, once imported goods and their embedded environmental impacts are included, remain far above the planetary boundaries for five out of 16 environmental impact categories as measured by Life Cycle Assessment using the EU Consumption Footprint (CF) model. These impact categories comprise: ecotoxicity (freshwater), particulate matter, climate change, resource use of fossil fuels, and minerals and metals. Unfortunately, these pollution and resource use patterns are trending upwards over time.

How to reverse these trends represents an unprecedented challenge to policy-makers.

The key insights provided by the CF and DF outlook proposed in this report are summarised as follows:

- The outlook to 2030 shows that the **continuation of existing trends** in consumption, under conditions of “**No Green Transition**”, that is without implementing fully a selection of recent green transition policies (under the umbrella of the European Green Deal) would both **worsen environmental impacts** of consumption and increase the transgression of the Earth's planetary boundaries by 2030.
- When considering Zero Pollution Action Plan targets, resource use and Circular Economy efforts (alongside increasing trends in consumption), projections for 2030 show that the EU has the **potential to significantly reduce impacts in all considered environmental categories**. By considering additional ambitions, the EU could reduce its consumption-related environmental impacts to levels below the ZPAP 2030 targets for nearly all environmental impact categories.
- A detailed analysis by areas of consumption shows that the greatest hotspots for creating synergies and opportunities for an effective result of green transition efforts include
 - **Housing**: reducing energy consumption in buildings via full implementation of the revised Energy Performance of Buildings Directive and the renovation wave initiative. If successfully addressed, these measures could substantially help the EU economy to decarbonise, in parallel reducing EU energy dependency on third countries.
 - **Food**: the scenarios with the greatest environmental benefits are linked to moving towards healthier and more sustainable diets. Together with a reduction in the use of pesticides, these measures could substantially reduce the impact from food consumption, e.g. by an order of several planetary boundaries.
- Detailed analysis by area of consumption demonstrates that there are **important positive and negative trends between areas of consumption**. While the opportunity in reducing impact in food and housing can provide greater benefits, these are often negatively offset environmentally by the effects of overall consumption growth in mobility, appliances, and household goods.

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List of abbreviations and definitions

Abbreviations for manuscript

BoP	Basket of representative Products
CF	Consumption Footprint
DF	Domestic Footprint
EF	Environmental Footprint
EGD	European Green Deal
ESPR	Eco-design for Sustainable Product Regulation
EU	European Union
GDP	Gross Domestic Product
GTT	Green Transition Target
HDI	Human Development Index
LCA	Life Cycle Assessment
LCI	Life Cycle Impact Assessment
LCT	Life Cycle Thinking
MIDAS	Modelling Inventory and Knowledge Management System
PB	Planetary boundary
SDG	Sustainable Development Goal
ZPAP	Zero Pollution Action Plan

Abbreviations for products and units of measurement

CFC	Chlorofluorocarbons
CTU	Comparative Toxic Unit
GJ	Gigajoule
HCFC	Hydrochlorofluorocarbon
LPG	Liquefied petroleum gas
NMVOG	Non-methane volatile organic compounds
MJ	Megajoule
TV	Television
W&W	Work & waterproof

Abbreviations for impact categories

AC	Acidification
CC	Climate change
ECOTOX	Ecotoxicity, freshwater
FEU	Eutrophication, freshwater
FRD	Resource use, fossils (impacts due to)
HTOX_c	Human toxicity, cancer
HTOX_nc	Human toxicity, non-cancer
IR	Ionising radiation
LU	Land use (impacts due to)
MEU	Eutrophication, marine
MRD	Resource use, minerals and metals (impacts due to)
ODP	Ozone depletion
PM	Particulate matter
POF	Photochemical ozone formation
TEU	Eutrophication, terrestrial
WU	Water use (impacts due to)

Annexes

Annex 1. Environmental Footprint impact categories

The table below, for every impact category, provides the Global Normalization Factor and the Weighting Factors that allow to calculate the Single Weighted Score with both DF and CF. as follows:

$$Single\ score = \sum_{n=1}^{16} \left(\frac{Impact\ value}{Global\ normalization\ factor} \times Weighting\ factor \right)$$

Impact category	Unit	Model adopted as in EF (Model robustness ^a)	Global normalisation factors ^b	Weighting factors ^c (%)	Planetary Boundaries
Climate change (GWP)	kg CO ₂ eq	Bern model - Global warming potentials (GWP) over a 100-year time horizon (based on Forster et al., 2021) (I)	7.55E+03	21.06	6.81E+12
Ozone depletion (ODP)	kg CFC-11 eq	EDIP model based on the ODPs of the World Meteorological Organisation (WMO) over an infinite time horizon (WMO 2014 + integrations) (I)	5.23E-02	6.31	5.39E+08
Particulate matter (PM)	Disease incidence	PM model (Fantke et al., 2016 in UNEP 2016) (I)	5.95E-04	8.96	5.16E+05
Ionising radiation (IR)	kBq U-235 eq.	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000) (II)	4.22E+01	5.01	5.27E+14
Photochemical ozone formation (POF)	kg NMVOC eq.	LOTOS-EUROS model (Van Zelm et al, 2008) as applied in ReCiPe 2008 (II)	4.09E+01	4.78	4.07E+11
Acidification (AC)	mol H ⁺ eq	Accumulated exceedance (Seppälä et al. 2006, Posch et al, 2008) (II)	5.56E+01	6.2	1.00E+12
Eutrophication, terrestrial (TEU)	mol N eq		1.77E+02	3.71	6.11E+12
Eutrophication, freshwater (FEU)	kg P eq	EUTREND model (Struijs et al, 2009) as applied in ReCiPe (II)	1.61E+00	2.8	5.81E+09
Eutrophication, marine (MEU)	kg N eq		1.95E+01	2.96	2.01E+11
Freshwater ecotoxicity (ECOTOX)	CTUe	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Andreasi Bassi et al. 2023 (III)	5.67E+04	1.92	1.31E+14
Human toxicity, non-cancer (HTOX_nc)	CTUh		1.29E-04	2.13	4.10E+06
Human toxicity, cancer (HTOX_c)	CTUh		1.73E-05	1.84	9.62E+05
Land use (LU)	Pt	Soil quality index based on LANCA model (De Laurentiis et al. 2019) and on the LANCA CF version 2.5 (Horn and Maier, 2018) (III)	8.19E+05	7.94	3.98E+15
Water use (WU)	m ³ water eq	Available WATER REMaining (AWARE) model (Boulay et al., 2018; UNEP 2016) (III)	1.15E+04	8.51	1.82E+14
Resource use, fossils (FRD)	MJ	ADP fossils (van Oers et al., 2002) (III)	6.50+04	8.32	2.24E+14
Resource use, minerals and metals (MRD)	kg Sb eq	ADP ultimate reserve (van Oers et al., 2002) (III)	6.36E-02	7.55	2.19E+08

^aEuropean Commission (2021); ^b Andreasi Bassi et al. (2023); ^c Sala et al. (2018)

The 16 impact categories of the EF 3.1 are used to assess the results of the CF and DF models and measured in different units, and relying on different models with different robustness indicated between 'I' high robustness (or high confidence in results), 'II' medium robustness (or medium confidence in results), and 'III' low robustness (or low confidence in results).

The table also shows the planetary boundaries for every impact category accounting for the total EU population, aligned with the EF 3.1 method, which helps comparing the results in relation to the environmental budget which is available to EU citizens and compared at the global scale.

Annex 2. Types of changes in Consumption and Domestic Footprint models

The **Consumption Footprint** integrates a bottom-up perspective, associated with the environmental impact of a unit of product described using LCA inventories and models, with a top-down perspective based on official statistics on product consumption (defined as annual consumption or consumption intensity). For the purpose of this analysis, no changes were implemented to the LCI data of the individual representative products neither in the use of the background LCI databases, namely ecoinvent 3.6 (Wernet et al., 2016) and Agrifootprint 5.0 (Blonk consultants, 2019).

Consequently, the modelling of scenarios and the inclusion of additional assumptions in the model can follow six possible approaches (or a combination thereof), as described below:

Changes to the assumption in the LCA inventory:

2. **Changes in parameter values:** the CF employs different sets of parameters to more effectively update the model (e.g., waste treatment parameters, food waste parameters, etc.). Since several targets necessitate modelling a percentage reduction of a certain substance from a specific reference year, this can be translated into a change in a parameter reduction. For instance, the target requiring a 50% reduction in the use of chemical pesticides from 2005 to 2030 could be modelled by adjusting the LCA parameter that controls the amount of pesticide used in each agricultural product, thereby reducing the environmental impact. This result, when multiplied by the consumption intensity of that product (or the annual volume of consumption), would yield the total pesticide reduction required by the targets being modelled.
3. **Process changes:** every product within the Consumption Footprint is modelled using the processes that comprise them. For example, the fuel production phase of a vehicle includes various fuel mixes, supplied through different supply chains such as ethanol and petrol. When the model did not include specific processes relevant to representing a particular target, this was used as a means to expand the model's scope. For instance, to model the targets requiring an increased presence of biofuel in the transport sector, the process [ethanol] was added to the fuel production process of "blended petrol with biofuel," and relevant parameters were included to control the associated processes, thus supporting the modelling of different scenarios.
4. **Addition of new products in the LCA inventory:** in some cases, certain targets might be considered beyond the scope of the initial model, necessitating a significant expansion to incorporate them. For example, to model a 25% increase in organic farming, a new supply chain for organic products had to be included in the Food Basket of Products. Alongside these new products, the processes and parameters that comprise the LCA inventory, as well as the associated consumption intensities (or annual consumption), needed to be collected using the approach described below.

Changes to Consumption Intensity data by 2030:

5. **Available modelling exercises:** whenever possible, data on consumption for 2030 were obtained from publicly available reports based on dynamic models that are considered reliable for projecting future production and consumption volumes. This approach was used for agricultural products (relying on scenarios from the Aglink-Cosimo and CAPRI models), as well as for appliances, transport, and energy output (using the National Energy and Climate Plans' scenario of the POTEnCIA model). Both models were used for the publication of the Agricultural Outlook 2023-2035 (EC, 2023e).
6. **Authors' assumptions based on public reports:** Given that some of the assumptions in the scenarios considered (particularly under the Green Transition Ambitions scenario) have not yet reached political consensus at the EU level, certain assumptions about possible consumption patterns had to be made. For instance, in modelling future consumption for a Sustainable and Healthy Diet, it was decided to use the consumption patterns proposed in the Food Lancet report (Willett et al. 2019), which suggested possible changes in EU consumption patterns to achieve sustainability.
7. **Extrapolation of public available data sources:** when none of the aforementioned possibilities could be considered, consumption intensities up to 2030 were modelled by means of extrapolating historical data into the future. Depending on the case, this could involve either a linear or log-linear regression based on current trends. For example, the extrapolation of real disposable income statistics was used as a proxy for modelling household goods consumption in 2030.

The **Domestic Footprint** utilises top-down official statistics on the production and use of substances that contribute to the environmental impacts described by the Environmental Footprint. Consequently, the modelling of scenarios and the inclusion of additional assumptions in the model follow two approaches:

8. **Extrapolation of historical data sources:** For the No GTT scenario up to 2030, the domestic footprint outlook was modelled by extrapolating historical data into the future. Depending on the case, this could involve either a linear or log-linear regression based on current trends. For example, in the case of climate change, extrapolation was used to simulate the outcome of no further policy efforts until 2030.
9. **Recalculation of targets in the context of DF model:** To model the GTT and GTT+ scenarios, the recalculation of the targets within the context of the domestic footprint was performed and compared with the No GTT scenario. If the targets were already achieved in the No GTT scenario, then the results of the calculated scenario were assumed to overlap with those of the No GTT scenario. Alternatively, the results of the calculated scenario were displayed. For example, in the case of climate change, further efforts are required to meet the target. The target was implemented in the GTT and GTT+ scenarios.

The Annexes 3 and 4 below specify the type of change made to the DF and CF models for each target modelled, based on the list provided.

Annex 3. Detailed assumption for Domestic Footprint

Climate Change

Policy context	
Target(s)	— Reduction of 55% greenhouse gas (GHG) emissions compared to 1990 levels (2040 target under discussion) ¹¹ <i>(Reference year for reduction: 1990 - despite several sub-targets make reference to the year 2005)</i>
Key policy document	— Proposal on a European 'Climate Law' enshrining the 2050 climate neutrality objective Establishing the framework for achieving climate neutrality and amending regulations (EC) No 401/2009 and (EU) 2018/1999 ("European Climate Law") (EPC, 2021a)
Target type	Legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+

¹¹ This targets integrates the effect of other targets with focus on the GHG emissions from different sectors:

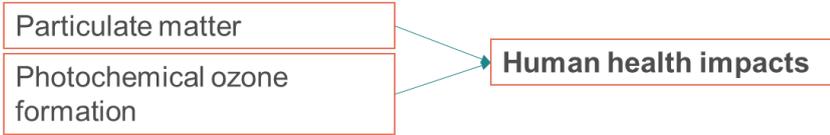
1. Reduce methane emissions of 35% as compared to 2005 levels.
2. The total quantity of allowances for the new EU Emissions Trading System (EU ETS) should follow a linear trajectory to reach the emission reduction target for 2030, taking into account the cost-efficient contribution of the buildings and road transport sectors of 43% emission reductions by 2030 compared to 2005 and of the additional sectors, a combined cost-efficient contribution of 42 % emission reductions by 2030 compared to 2005.
3. The contribution of the sectors covered by the EU ETS with respect to the EU climate ambition should be of -62 % compared to 2005 (increasing the linear emissions reduction factor from 2.2 % per year up to 4.4 %).
4. Upgrade national targets in line with an EU-wide reduction of 40% in the Effort Sharing Regulation (ESR) sectors compared to 2005. Member States contribute to the overall EU reduction in 2030 with targets ranging from -10% to -50% below 2005 level (sectors: transport, buildings, agriculture and waste).
5. Achieve an EU net GHG removal of 310 million tonnes CO₂ equivalent per year for the land use, land use change and forestry (LULUCF) sector.
6. To achieve 55% reduction of GHG emissions by 2030, methane emissions related to energy production and consumption should be reduced by 58% compared to their level in 2020.
7. For the period from 2021 to 2025 each Member State must ensure that greenhouse gas emissions from the sector do not exceed greenhouse gas removals, calculated as the sum of total emissions and total removals on its territory in all of the land accounting categories (no debit rule). The accounting benchmark for the EU is ca. -229 Mt CO₂ equivalent per year for 2021-2025.
8. Reduce buildings' GHG emissions by 60%, compared to 2015 levels, by 2030.
9. Cut the emissions of the transport sector by 90%.
10. The average CO₂ emissions of the Union fleet of new heavy-duty motor vehicles, other than special purpose, off-road, off-road special purpose, and vocational vehicles shall be reduced by the following percentages compared to the average CO₂ emissions of the reporting period of the year 2019: (a) for vehicle sub-groups 4-UD, 4-RD, 4-LH, 5-RD, 5-LH, 9-RD, 9-LH, 10-RD, 10-LH for the reporting periods of the years 2025 to 2029 by 15 %; for all vehicle sub-groups for the reporting periods of the years 2030 to 2034 by 45 %.

Technical inputs to modelling	
Impact category(ies)	Climate change
Environmental pressures	All Greenhouse Gas emissions
Variable	Overall GHG emissions in terms of kg CO ₂ equivalent.
Variable type	Environmental pressure
Type of edit in the model	<ul style="list-style-type: none"> — Extrapolation of historical data sources (#7 in Annex 2): No GTT, — Recalculation of targets in the context of DF model (#8 in Annex 2): GTT, GTT +.
Modelling description	<p>The target aims to achieve a 55% reduction in GHG emissions compared to 1990 levels (approximately 4.6 billion tonnes of CO₂ equivalent¹) by 2030, as an initial step towards reaching the 2040 target (a 90% reduction) and attaining climate neutrality by 2050. This would result in an annual emission level of around 2.1 billion tonnes of CO₂ equivalent.</p> <ul style="list-style-type: none"> — No GTT: a linear regression has been calculated to predict the continuation of current trends. — GTT and GTT +: these scenarios assume that the climate change impact value is reduced to the target of <u>2.1 billion tonnes of CO₂ equivalent</u>. A linear decrease to reach the target has been assumed for the period from 2023 to 2030.
Limitations in modelling	The granularity of the DF does not allow one to assess individual sectors and targets, but rather the overall GHG emissions target.

Land use

Policy context	
Target(s)	Reach no net land take (Reference year for reduction: NA)
Key policy document	— EU Soil Strategy for 2030 (EC, 2021d)
Target type	Not legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT +
Technical input to modelling	
Impact category(ies)	Land use
Environmental pressures	Land transformation to urban areas (Settlements)
Variable	Land transformation
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT. — Recalculation of targets in the context of DF model (#8 in Annex 2): GTT +.
Modelling description	The target is expected to reduce to zero the net land take, thereby limiting the transformation of natural land to settlements. — NO GTT//GTT : The latest trend was projected for the different land occupation and land transformation environmental pressures, based on historical data. — GTT + : For modelling such achievement, the land transformation to settlement from other types of land use have been set to 0. Land occupations environmental pressures are projected based on historical data.
Limitations in modelling	No specific limitations have been identified.

Particulate matter and Photochemical ozone formation

Policy context	
Target(s)	<ul style="list-style-type: none"> — Improve air quality to reduce the number of premature deaths caused by air pollution by 55% by 2030.¹² <p><i>(Reference year for reduction: 2005)</i></p>
Key policy document	— Zero Pollution Action Plan (EC, 2021b)
Target type	Not legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical input to modelling	
Impact category(ies)	<ul style="list-style-type: none"> — Photochemical ozone formation — Particulate matter
Environmental pressures	— Air pollution
Variable	Air emissions of pollutants contributing to particulate matter and photochemical ozone formation.
Variable type	Environmental pressure
Type of edit in the model	<ul style="list-style-type: none"> — Extrapolation of historical data sources (#7 in Annex 2): No GTT. — Recalculation of targets in the context of DF model (#8 in Annex 2): GTT, GTT +.
Modelling description	<p>The target aims to achieve a 55% reduction of particulate matter compared to 2005 levels (from 593 thousand disease incidence to 326 thousand disease incidence in 2030).</p> <ul style="list-style-type: none"> — No GTT: linear regression has been calculated to predict the continuation of current trends. — GTT /GTT+: A linear relationship is assumed between the target addressing human health impacts at damage level (premature death) and the impact assessed in the Environmental Footprint indicator. The impacts are modelled to be decreased by 55%.  <pre> graph LR A[Particulate matter] --> C[Human health impacts] B[Photochemical ozone formation] --> C </pre>
Limitations in modelling	No specific limitations have been identified.

¹² Other targets contribute to the overall 55% reduction: "The revision of the Ambient Air Quality Directives would merge the Directives into one and seek to: align EU air quality standards more closely with WHO recommendations further improve the legislative framework (e.g. in relation to penalties, and public information). The Directive sets out a zero pollution objective for air quality, so that within the Union air quality is progressively improved to levels no longer considered harmful to human health and natural ecosystems, as defined by scientific evidence, thus contributing to a toxic-free environment at the latest by 2050."

Eutrophication, marine; Eutrophication, freshwater; Eutrophication, terrestrial

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduction of 50% of nutrient losses — Reduction of 20% of the use of fertilisers <p><i>(Reference year for reduction: 2005)</i></p>
Key policy document	<ul style="list-style-type: none"> — Farm to Fork Strategy (EC, 2020d) — Zero Pollution Action Plan (EC, 2021b) — Biodiversity Strategy (EC, 2020a).
Target type	Not legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT+
Technical inputs to modelling	
Impact category(ies)	<ul style="list-style-type: none"> — Eutrophication, freshwater — Eutrophication, marine — Eutrophication, terrestrial
Environmental pressures	Emission of nutrient losses to the environment
Variable	Emissions of nutrient losses to the environment
Variable type	Environmental pressure
Type of edit in the model	<ul style="list-style-type: none"> — Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT. — Recalculation of targets in the context of DF model (#8 in Annex 2): GTT +.
Modelling description	<p>The target aims to reduce by 50% current nutrient losses from 2005 and 20% the use of fertilisers from 2005.</p> <ul style="list-style-type: none"> — No GTT//GTT: linear regression has been calculated to predict the continuation of current trends. — GTT +: <ul style="list-style-type: none"> • Terrestrial eutrophication: 20% of reduction of nitrogen emissions and ammonia emissions to air is assumed. • Marine and freshwater eutrophication: <ul style="list-style-type: none"> ▪ Agricultural emissions of nitrogen to water have been modelled to match the target of 50% reduction of nutrient loss. ▪ Nitrogen and phosphorous emissions from wastewater have been modelled following current decreasing trends resulting from improvements in wastewater technology, based on historical data (2000-2022).
Limitations in modelling	No specific limitations have been identified.

Acidification

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduce by 25% the EU ecosystems where air pollution threatens biodiversity <p><i>(Reference year for reduction: 2017)</i></p>
Key policy document	Zero Pollution Action Plan (EC, 2021b)
Target type	Not legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical inputs to modelling	
Impact category(ies)	Acidification
Environmental pressures	Acidifying emissions
Variable	Acidifying emissions
Variable type	Environmental pressure
Type of edit in the model	<ul style="list-style-type: none"> — Extrapolation of historical data sources (#7 in Annex 2): No GTT. — Recalculation of targets in the context of DF model (#8 in Annex 2): , GTT, GTT +.
Modelling description	<p>Different legislations contribute to reducing the overall emissions of acidifying substances causing terrestrial acidification. Acidification impacts have shown a decreasing trend up to 2022. This contributes to a reduction in the negative effects of pollution on ecosystems and biodiversity.</p> <p>The target consists of reducing the volume of the pollutants that contribute to acidification by 25% from the levels in 2017, with associated reduction on the impact on biodiversity.</p> <ul style="list-style-type: none"> — NO GTT: linear regression has been calculated to predict the continuation of current trends — GTT/GTT +: reducing the selected pollutants from 10.9 billion mol H+ eq in 2017 to 8.1 billion mol H+ eq. in 2030.
Limitations in modelling	No specific limitations have been identified.

Freshwater eco-toxicity, human toxicity (both cancer and non-cancer): pesticides reduction related

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduction of 50% of use of pesticides — Improve soil quality by reducing nutrient losses and chemical pesticides' use by 50% (target partially in common with the Farm to Fork strategy and Biodiversity strategy) - focus on soil quality and pesticides — Improve soil quality by reducing nutrient losses and chemical pesticides' use by 50% (target partially common with the Farm to Fork strategy and Biodiversity strategy) - focus on water quality and chemical pesticides <p><i>(Reference year for reduction: 2005)</i></p>
Key policy document	<ul style="list-style-type: none"> — Farm to Fork Strategy (EC, 2020d) — Common Agricultural Policy (EC 2013) — Biodiversity Strategy (EC, 2020a) — Zero Pollution Action Plan (EC, 2021b)
Target type	Not legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT , GTT +
Technical inputs to modelling	
Impact category(ies)	<ul style="list-style-type: none"> — Freshwater ecotoxicity — Human toxicity (cancer) — Human toxicity (non-cancer)
Environmental pressures	Emissions to the environment of pesticides
Variable	Overall pesticides emissions
Variable type	Environmental pressure
Type of edit in the model	<ul style="list-style-type: none"> — Extrapolation of historical data sources (#7 in Annex 2): No GTT. — Recalculation of targets in the context of DF model (#8 in Annex 2): GTT, GTT+.
Modelling description	<p>The target is expected to reduce pesticides use by 50% from the reference value in 2005.</p> <ul style="list-style-type: none"> — No GTT and GTT: linear regression has been calculated to predict the continuation of current trends. — GTT /GTT +: Considering that the modelling of pesticides emission is based on pesticides use in agriculture as well as due to industry activity, this target has been modelled by selecting the emissions from pesticides and reducing them by 50% in comparison to their value in 2005.
Limitations	No specific limitations have been identified.

Freshwater eco-toxicity, human toxicity (both cancer and non-cancer): non pesticides related

Policy context	
Target(s)	NA <i>(Reference year for reduction: NA)</i>
Key policy document	— Industrial Emissions Directive (EPC 2024a) — Mercury regulation (EC 2017)
Target type	NA
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical inputs to modelling	
Impact category(ies)	— Freshwater ecotoxicity — Human toxicity, cancer — Human toxicity, non-cancer
Environmental pressures	Toxic emissions (apart from pesticides from agriculture)
Variable	Toxic emissions (apart from pesticides from agriculture)
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT all targets, GTT ambitions.
Modelling description	Although no specific target is related to toxicity targets which do not directly link to pesticides reductions, many legislations address the emission of toxic pollutants to the environment, leading to a constant decrease along time. — No GTT/GTT /GTT + : Linear regression has been used to project the trend until 2030 based on 2000-2022 data.
Limitations in modelling	No specific limitations have been identified.

Ozone depletion

Policy context	
Target(s)	NA (Reference year for reduction: NA)
Key policy document	— Montreal protocol (UNEP 1987) — Ozone depletion regulations (EPC 2024b)
Target type	NA
Reference Year	NA
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+.
Technical inputs to modelling	
Impact category(ies)	Ozone depletion
Environmental pressures	Ozone depleting emissions
Variable	Overall ozone depleting emissions in terms of kg CFC-11 equivalent.
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT, GTT +.
Modelling description	Although no specific target is related to ozone depletion, the Montreal Protocol established global bans to specific products associated to the emission of ozone depleting substances that have led to a constant decrease over time. — No GTT/GTT /GTT + : The average trend of the last five years was projected until 2030 (as linear regression was not representing properly the slowing down of the decreasing trend for the last period).
Limitations in modelling	The granularity of the DF doesn't allow to assess individual sectors and targets that might have an effect on ozone depletion.

Ionising radiation

Policy context	
Target(s)	NA (Reference year for reduction: NA)
Key policy document	NA
Target type	NA
Scenario scenarios	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Impact category(ies)	Ionising radiation
Environmental pressures	Emission of radionuclides
Variable	Emission of radionuclides
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT, GTT +.
Modelling description	Although no specific target is related to the emission of radionuclides, a constant decrease has been observed in the EU. — No GTT/GTT /GTT + : Linear regression has been used to project the trend until 2030 based on 2000-2022 data.
Limitations in modelling	No specific limitations have been identified.

Resource use, fossils and Resource use, minerals and metals

Policy context	
Target(s)	NA (Reference year for reduction: NA)
Key policy document	— Circular economy action plan (EC, 2020b) — Resilient energy union (EC, 2015).
Target type	NA
Reference year	NA
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical inputs to modelling	
Impact category (ies)	Resource use, fossils Resource use, minerals and metals
Environmental pressures	Extraction of fossils resources and minerals and metals
Variable	Extraction of fossils resources and minerals and metals
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT, GTT +.
Modelling description	Different targets are underlying changes in the extraction of resources use, both fossils and minerals and metals – although no overall target has been defined. Fossil resources has shown a decreasing trend over time, which might be associated to the energy transition Minerals and metals resources, instead, have shown an increasing trend which might be linked to the green transition and the associated technological demand. — No GTT/GTT /GTT + : Linear regression has been used to project the trend until 2030 based on 2000-2022 data.
Limitations in modelling	The DF data employs overall extraction data without granularity to model the role of different economic sectors with associated targets.

Water use

Policy context	
Target(s)	NA (Reference year for reduction: NA)
Key policy document	Circular economy action plan (EC, 2020b) Water Framework Directive (EPC, 2000)
Target type	NA
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical inputs to modelling	
Impact category	Water use
Environmental pressures	Use of water
Variable	Use of water
Variable type	Environmental pressure
Type of edit in the model	— Extrapolation of historical data sources (#7 in Annex 2): No GTT, GTT, GTT +.
Modelling description	Different legislations contribute to reducing the overall consumption of water resources in the EU, from being more efficient to circular economy strategies like water reuse. Water use impacts have shown a decreasing trend up to 2022. No overall target on water resources is defined at the EU level, and the current trajectory is projected up to 2030. — No GTT/GTT /GTT + : Linear regression has been used to project the trend until 2030 based on 2000-2022 data.
Limitations in modelling	The DF data employs overall extraction data without granularity to model the role of different economic sectors with associated targets.

Annex 4. Detailed assumption for Consumption Footprint

This annex describes the key assumptions applied to the Consumption Footprint model. These are structured according to the five groups (or “baskets”) of products: food, mobility, housing, appliances and household goods. In addition to these, cross-cutting themes (i.e., those having an impact on more than one basket of products at the same time, such as electricity generation) have been grouped: energy, transport, waste treatment, batteries end of life, recycling and packaging.

This modelling exercise is an example of how the Consumption Footprint (CF) model can be used to generate projection scenarios for the future. It is worth noting that CF-type models (relying on Attributional LCA) do not consider feedback loops (e.g. change in conditions or system response) between different parts of the model. As a result, the analysis is instructive to examining the type of environmental impacts that green transition policies and ambitions could have achieved, but it does not show the process of how to achieve these targets.

To further support the interpretation of the results, the tables below provide detailed additional information on the modelling assumptions underpinning the simulations within the CF model. For each basket of products and corresponding targets, they include information on:

- **Policy context:** description of the target, reference to the key policy documents, target type;
- **Scenario assumptions:** inclusion in the considered scenarios;
- **Technical inputs to modelling:** types of edit made within the CF model, relevant area of consumption, product scope, variable, variable type, modelling description and specific limitations in modelling.

Food

The modelling of the targets requires the projections of the consumption intensity of the different food products covered as its basis. These products are based on the published data in the EU Agricultural Outlook for Markets, 2023-2035 (EC, 2023e). The outlook covers the following representative products/product groups: butter, beef and veal, cheese, eggs, fresh dairy products, oilseed oils, pork, pulses, poultry, rice, roots and tubers, sugar, fruits and vegetables. For the remaining products, current consumption intensities have been projected. These include those products listed below, which are not currently considered in the agricultural outlook: wine, beer, water, bread, pasta, quinoa, biscuits, chocolate, coffee, tea, milk, cream, cod, salmon, tuna, tofu, soy milk and meat-based dishes.

Reduction in fertiliser use and nutrient losses

Policy context	
Target(s)	<ul style="list-style-type: none"> — The losses of nutrients from fertilisers are reduced by 50%, resulting in the reduction of the use of fertilisers by at least 20% — Reduce nutrient losses by at least 50%, while ensuring no deterioration in soil fertility <p><i>(Reference year for reduction: 2005)</i></p>
Key policy document	<ul style="list-style-type: none"> — Farm to Fork Strategy (EC, 2020d) — Zero Pollution Action Plan (EC, 2021b)
Target type	Not legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT +
Technical inputs to modelling	
Area of consumption	Food
Product scope	Agricultural stage affecting crop for food and feed production in Europe
Variable	Fertiliser consumption as agricultural input Emissions due to fertiliser application to the environment
Variable type	Life cycle element (element in the background inventory ¹³)
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	Potential yield reductions are not considered due to the uncertainty of a relationship between changes in the characteristics of future fertilisers and the resulting yield.

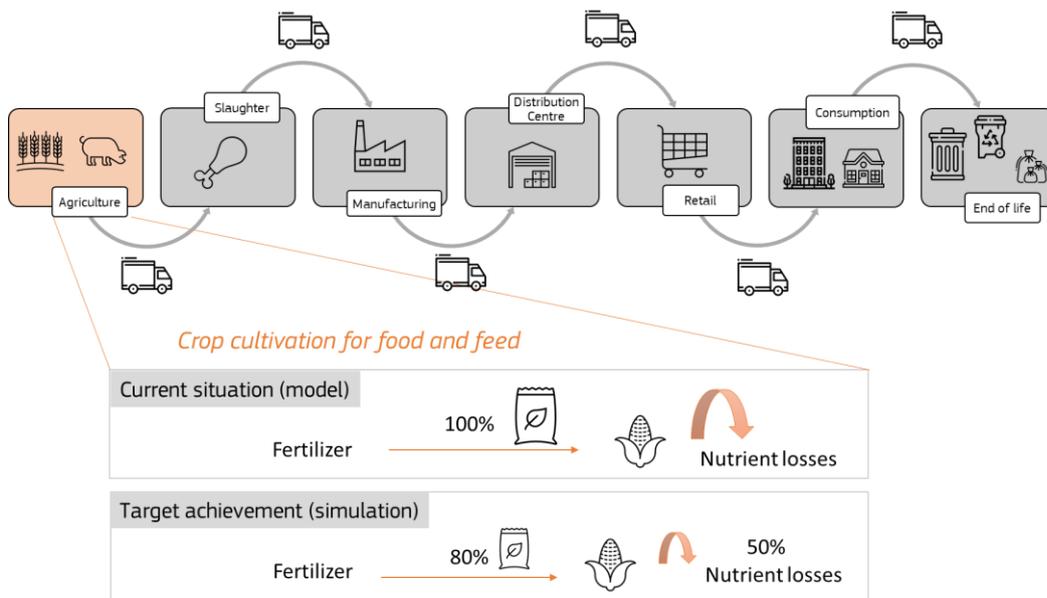
¹³ The Background inventory is intended as a part of the Life Cycle inventory which is embedded among Ecoinvent © or Agrybalyse © data which feed the Consumption Footprint model.

Modelling description

The modelling of a 20% reduction in fertilisers and a 50% reduction in nutrient loss is included in the Consumption Footprint model by applying a change in parameters in the Agriculture life cycle stage (see figure below) of crops, leading to an associated reduction in emissions to the environment.

The targets apply to all crops dedicated to human consumption and animal feed production. Due to the design of the Consumption Footprint, fertilizers and nutrient loss are modelled as part of the background data (i.e., life cycle inventory databases like Ecoinvent 3.6 or Agrifootprint), where fertiliser use and its emissions are modified by including relative parameters that are varied to simulate different scenarios. Specifically, emissions from fertiliser application are reduced by 50% (e.g., ammonia emissions, phosphate emissions).

It is worth noting that the production and application of fertilisers, including their entire life cycle (from the extraction of raw materials to their use on agricultural land), as well as the packaging required to store and transport fertilisers, are considered in the background dataset of the Consumption Footprint. As a result, the 20% reduction in fertiliser use implies a cascading impact on its supply chain, leading to an associated reduction in resource use and emissions along the entire life cycle of the fertilizer.



Source: JRC elaboration.

Pesticide reduction

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduce by 50% the use and risk of chemical pesticides — The risk and use of chemical pesticides is reduced by 50%, and the use of more hazardous pesticides is reduced by 50% — Improve soil quality by reducing nutrient losses and chemical pesticides' use by 50% - focus on soil quality and pesticides. Improve soil quality focusing on water quality and chemical pesticides <p><i>(Reference year for reduction: 2005)</i></p>
Key policy document(s)	<ul style="list-style-type: none"> — Farm-to-Fork Strategy (EC, 2020d) — Biodiversity Strategy (EC, 2020a) — Zero Pollution Action Plan (EC, 2021b) — Proposal on the sustainable use of plant protection products and amending Regulation (EU) 2021/2115 (EC, 2022c)
Target type	Not legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Area of consumption	Food
Product scope	Agricultural stage affecting crop for food and feed production in Europe
Variable	Amount of pesticides used in agricultural production Emissions of pesticides ingredients and residuals to the environment
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2) Process changes (#2 in Annex 2)
Limitations in modelling	Potential yield reductions are not taken into account due to the uncertainty surrounding the relationship between changes in the characteristics of future pesticides and their impact on yields.

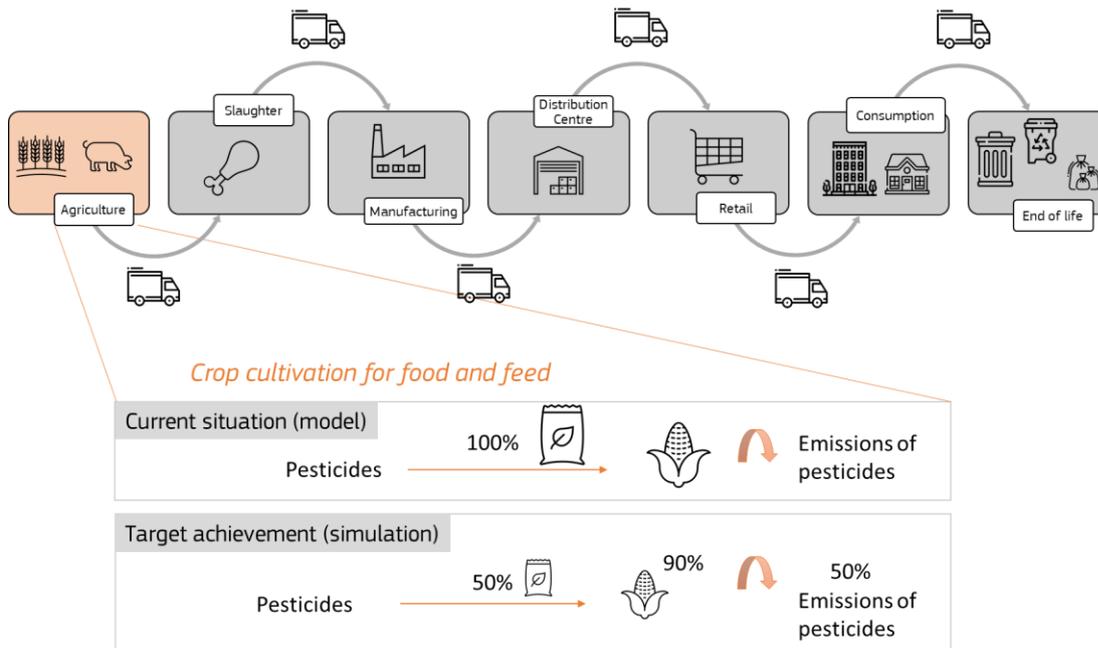
Modelling description

The modelling of a 50% reduction in pesticides in the Consumption Footprint is applied to the Agriculture life cycle stage, where the application of the pesticides occurs.

The modelling involves two steps. Firstly, the more hazardous pesticides included in the CF model have been replaced with approved less hazardous pesticides, such as Glyphosate. Secondly, all the resulting list of pesticides has been reduced by 50% in terms of use and associated emissions.

Similarly to the case of fertiliser reduction, pesticides are also modelled as part of the background inventory (e.g., data from Ecoinvent and Agri-footprint) for all crops, whether for human consumption or animal feed. As a result, the Consumption Footprint model takes into account the entire life cycle of pesticides, from the extraction of raw materials to their application to agricultural land. This means that, the linear reduction in emissions from pesticides into soil and water, resulting from reduced pesticide application in agriculture, also leads to a reduction in resource use and emissions throughout the entire life cycle of the pesticide, including packaging.

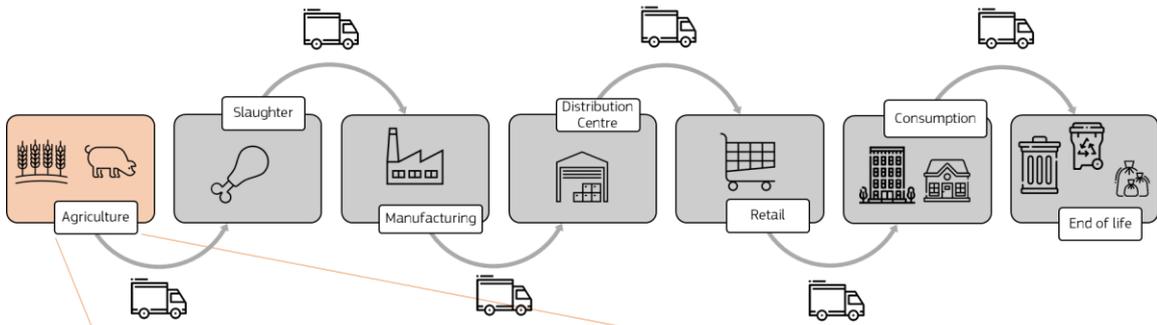
The scenario for approved pesticides is considered to be achieved in both the **GTT** and **GTT +** scenarios.



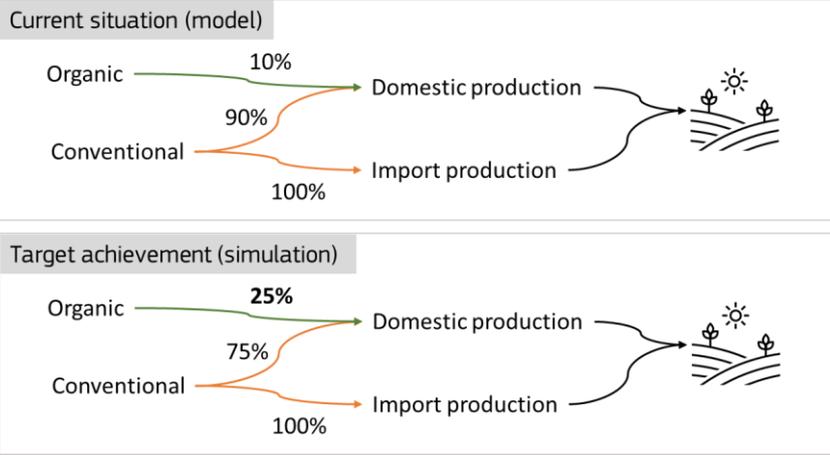
Source: JRC elaboration.

Organic farming expansion

Policy context	
Target(s)	— Increase organic farming with the aim to achieve at least 25% of total farmland under organic farming by 2030 (Reference year for expansion: 2030)
Key policy document	— Farm to Fork Strategy (EC, 2020d) — Biodiversity Strategy (EC, 2020a)
Target type	Not legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT+
Technical inputs to modelling	
Type of edit to the model	Available modelling exercises (#4 in Annex 2) Addition of new products (#3 in Annex 2)
Area of consumption	Food
Product scope	Agricultural stage affecting crop for food and feed production in Europe
Variable	Share of organic production
Variable type	Life cycle element / Consumption intensity
Limitations in modelling	Imported products are assumed to be 100% conventional. Proxy impact data and consumption intensity data for a food product are used as a proxy for the food group to which this product belongs (e.g. almonds and cashews are used as representatives of the 'nuts and seeds' group). The share of organic production is modelled as a percentage of land devoted to organic production (i.e. the target is 25%). Consequently, differences in crop yield are not taken into account.
Modelling description	
<p>To model the consumption of organic products, the consumption intensity of a given product needs to be split between conventional and organic, and specific LCI models must be compiled for organic products. Additional analysis using the Agrybalise database has been undertaken.</p> <p>Consumption intensity: The percentage of organic production in the EU is modelled by adjusting the share of domestic production that adheres to organic practices. The shares of conventional and organic products are calculated based on the organic share of land and market data related to production and imports, as follows:</p> $\begin{aligned} \text{Total consumption (kg)} &= \text{Conventional (kg)} + \text{Organic (kg)} \\ \text{Conventional share (\%)} &= \text{Imported (\%)} + \text{Domestic (\%)} * \text{Conventional (\%)} \\ \text{Organic share (\%)} &= \text{Domestic (\%)} * \text{Organic (\%)} \end{aligned}$ <p>The import and domestic shares are based on PRODCOM and FAOSTAT data, as used in the Consumption Footprint model.</p> <p>LCI models for organic products: Organic farm data are available for products in each food group in the LCI background database, and are used as proxy data to cover the impacts of the food categories. This relates to both the impact data and the consumption intensity data.</p>	



Crop cultivation for food and feed



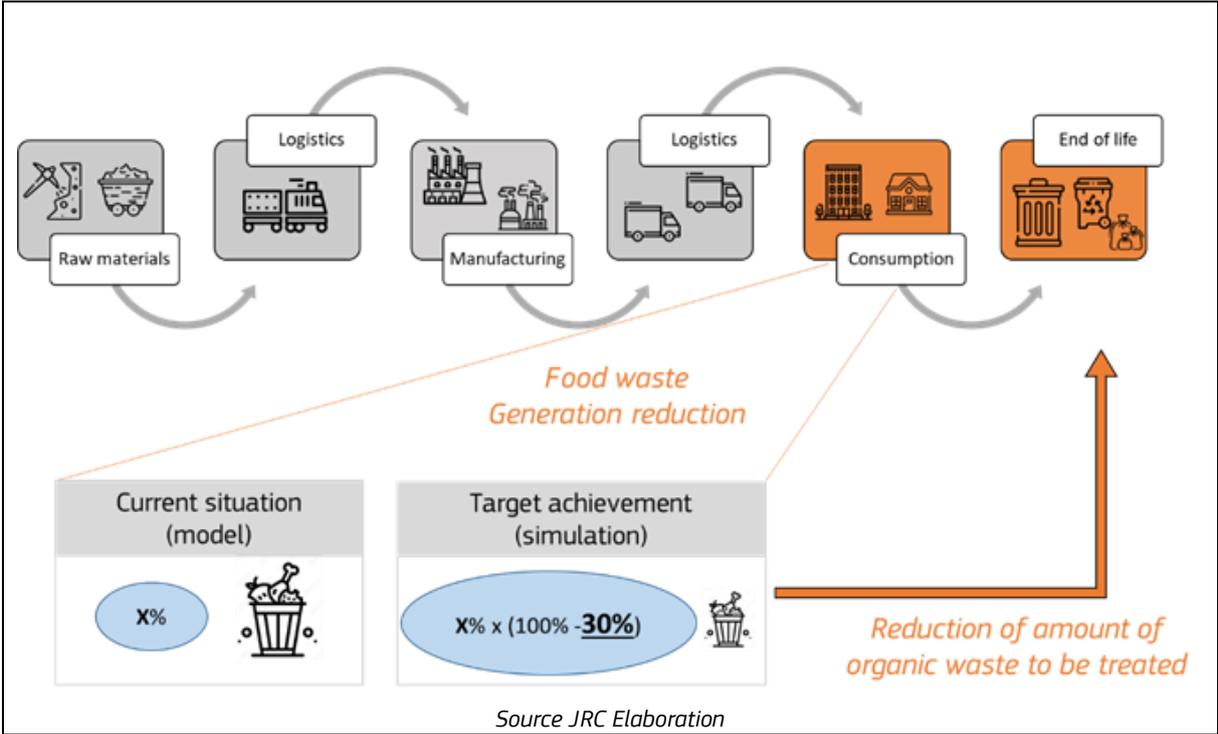
Source: JRC elaboration.

Food waste reduction in processing and manufacturing

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduce the generation of food waste in processing and manufacturing by 10% in comparison to the amount generated in 2020. <p><i>(Reference year for reduction: 2020)</i></p>
Key policy document	<ul style="list-style-type: none"> — EC proposal for amending Directive 2008/98/EC on waste (EC, 2023f) — Commitment for food waste reduction is included in the Farm to Fork Strategy (EC 2020d)
Target type	Non-legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT +
Technical inputs to modelling	
Area of consumption	Food
Product scope	Food waste generation and management
Variable type	Life cycle element
Variable	Share of food waste generation at processing and manufacturing
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	No specific limitations have been identified.
Modelling description	
<p>The CF model takes into account the different intensities of food waste generation at each stage of the supply chain for food products. The model's values are currently based on the JRC Food waste mass flow¹, which provides coefficients for each stage of the supply chain for each food product.</p> <p>To model a 10% reduction in food waste in processing and manufacturing, the food waste coefficients (X%) have been adjusted to reflect this reduction. This adjustment affects the amount of food waste generated in this life cycle stage, as well as the quantity of organic waste that is treated at the end of life of each food product.</p>	
<p style="text-align: center;"><i>Food waste Generation reduction</i></p> <p style="text-align: center;"><i>Reduction of amount of organic waste to be treated</i></p>	
<p><i>Source: JRC elaboration.</i></p>	

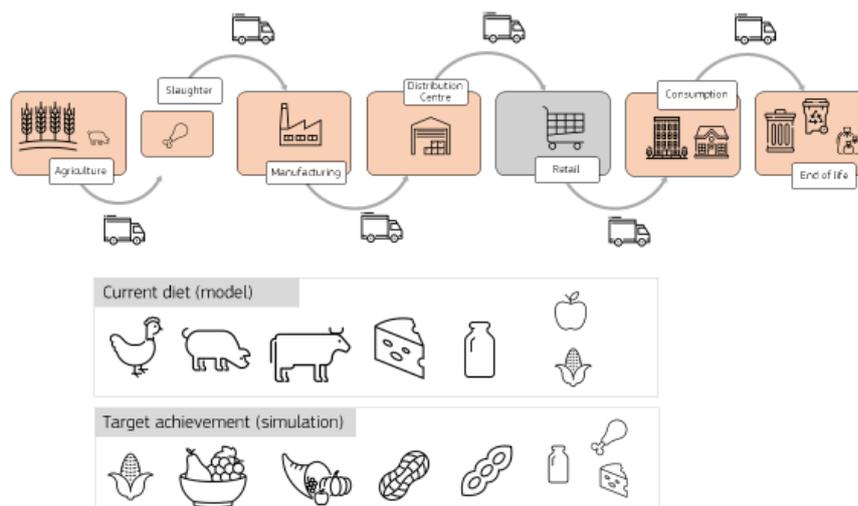
Food waste reduction in retail and consumption

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduce the generation of food waste per capita, jointly in retail and other distribution of food, in restaurants and food services and in households, by 30 % in comparison to the amount generated in 2020. <p><i>(Reference year for reduction: 2020)</i></p>
Key policy document	<ul style="list-style-type: none"> — EC proposal for amending Directive 2008/98/EC on waste (EC, 2023f) — Commitment for food waste reduction is included in the Farm to Fork Strategy (EC, 2020d)
Target type	Not legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT+
Technical inputs to modelling	
Area of consumption	Food
Product scope	Food waste generation and management
Variable	Reduce the generation of food waste at retail, distribution and consumption stage (including households and eating-out) and accordingly adjust the waste management
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	No specific limitations have been identified.
Modelling description	
<p>The CF model considers different intensities of food waste generation along the supply chain of food products. The model's values are currently based on the JRC Food waste mass flow (De Laurentiis et al., 2023), which provides coefficients for each stage of the supply chain for each food product.</p> <p>To model a 30% reduction in food waste in retail and consumption, the food waste coefficients (X%) have been adjusted to reflect this reduction. This adjustment affects the amount of food waste generated in this life cycle stage, as well as the quantity of organic waste that is treated at the end of life of each food product.</p>	



Sustainable and Healthy Diet

Policy context	
Target(s)	— Move to healthier and more sustainable diets <i>(Reference year for reduction: NA)</i>
Key policy document	— The Farm to Fork Strategy aims at promoting sustainable food consumption and facilitating the shift to healthy, sustainable diets (EC, 2020d)
Target type	Non legally binding / Ambition
Scenario assumptions	
Target reached in scenario(s)	GTT +
Technical inputs to modelling	
Area of consumption	Food
Product scope	All food products
Variable	Consumption per capita by food product
Type of edit to the model	— Changes in parameter values (#1 in Annex 2) Available modelling exercises (#4 in Annex 2)
Variable type	Annual consumption
Limitations in modelling	The amounts of coffee and tea have not been altered because they are not included in the EAT-Lancet diet simulation. The impact of plant-based diets on water usage strictly depends on the type of products (including irrigation methods and geographical areas considered) that replace animal-based products. For example, almonds consumed in the EU are imported from regions where this crop is heavily irrigated (such as California, which produces over 60% of the world's almonds). The impact of diets on the use of mineral and metal resources depends on the packaging of the food product (for instance, canned tuna or canned chickpeas).
Modelling description	
<p>The diet proposed by the EAT-Lancet Commission on Healthy Diets (Willet et al., 2019) has been used as a target for a healthy and sustainable diet. This diet involves a comparison with current patterns, which includes:</p> <ul style="list-style-type: none"> — an increase in the consumption of cereals, legumes, nuts and seeds, and vegetables and fruits; — a significant reduction in meat, pre-prepared meals, sugar, and stimulants (such as alcohol and coffee). <p>In order to model the target diet, the following relative changes in consumption per product were assumed, compared to 2022 consumption patterns, taking into account per capita diet. These estimates are based on Sanye Mengual et al. (2024b).</p> <p>Assumptions regarding sugar and confectionery reductions are based on the consumption intensity for EU-27 in 2022 and the recommended amounts obtained from the EAT Lancet report. Estimates for all beverages are based on national recommendations and consumption intensities.</p>	



Source JRC Elaboration

Product group	Products	Diet change - EAT-Lancet*
Beverages	Beer	77%
Beverages	Mineral water	175%
Beverages	Wine	71%
Cereal-based products	Bread, Pasta, Rice, Quinoa	185%
Coffee and tea	Coffee, Tea	100%
Confectionary products	Biscuits, Chocolate, Sugar	30%
Dairy	Butter, Cheese, Milk	65%
Eggs	Eggs	45%
Fish and seafood	Cod, Salmon, Shrimp, Tuna (canned)	105%
Fruits	Apples, Bananas, Oranges, Avocado, Strawberry	145%
Legume-based products	Soy beverage, Tofu	180%
Legumes	Beans, Chickpeas, Lentils	180%
Meat	Beef meat (cattle)	22%
Meat	Beef meat (dairy)	22%
Meat	Pig meat	22%
Meat	Poultry meat	80%
Nuts and seeds	Almonds, Cashew	190%
Oils	Olive oil, Sunflower oil, Palm oil, Rapeseed oil, Soybean oil	76%
Pre-prepared meals	Pre-prepared meals	40%
Tubers	Potatoes	24%
Vegetables	Tomatoes, Broccoli, Carrot	125%

* Current consumption is set as 100%

Mobility

Advanced biogas and biofuels

Policy context	
Target(s)	<p>— Each Member State shall set an obligation on fuel suppliers to ensure that:</p> <p>(B) the combined share of advanced biofuels and biogas produced from the feedstock listed in Part A of Annex IX and of renewable fuels of non-biological origin in the energy supplied to the transport sector is at least 1 % in 2025 and 3,5 % in 2030, of which a share of at least 1 percentage point is from renewable fuels of non-biological origin in 2030.</p> <p><i>(Reference year for expansion: 2030)</i></p>
Key policy document	— Directive on the promotion of energy from renewable sources (EPC, 2023a)
Target type	Legally-binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Area of consumption	Mobility
Product scope	This target affects all vehicles, apart from electric ones and airplanes
Variable	Share of biofuels and biogas in the overall fuel consumed by vehicle
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	Advanced biogas and biofuels (e.g., Hydrotreated Vegetable Oils (HVO) / Hydroprocessed Esters and Fatty Acids (HEFA) ¹⁴) are not available in the life cycle inventory database used in the model (i.e., Ecoinvent). Consequently, a conventional biogas and biofuel have been used as a proxy.
Modelling description	
<p>In the Consumption Footprint model, various types of fuel can be considered to meet the fuel demand of vehicles. To model the increasing uptake of advanced biofuels and biogas in the transport sector, the share of biogas or biofuel (including advanced biofuels) contributing to the total fuel consumption of a road vehicle has been adapted to the characteristics of each scenario. The model changes are applied as in the phase of fuel production which remains constant throughout the projected time period and takes into account the consumption of both:</p> <ul style="list-style-type: none"> — conventional fuels (i.e. diesel, petrol, compressed natural gas, and liquefied natural gas) — biofuels or biogas <p>Note that in the current fuel market, traditional biofuels already account for 5% of petrol and 7% of diesel blends. This target addresses the uptake of advanced biofuels, which are modelled by considering the additional uptake of these innovative fuels.</p>	

¹⁴ <https://www.etipbioenergy.eu/value-chains/products-end-use/products/hvo-hefa>

As the Consumption Footprint model considers different mobility technologies, the uptake of biogas or biofuel was modelled for each technology in terms of their share of total fuel production (i.e. thereby accounting for their differences in fuel efficiency) as follows:

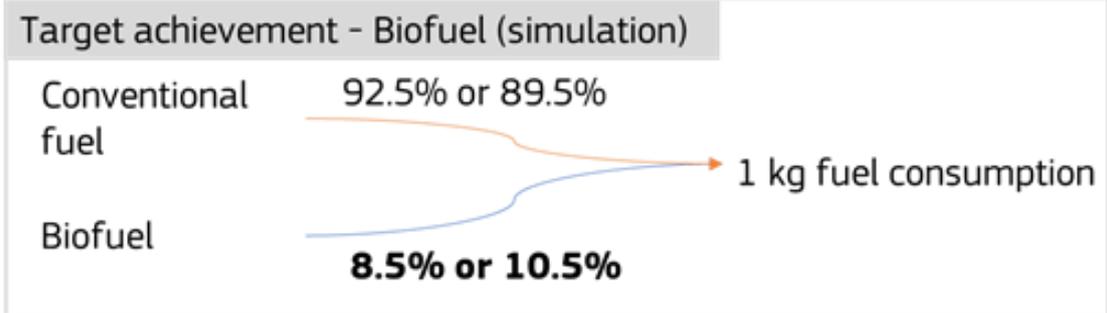
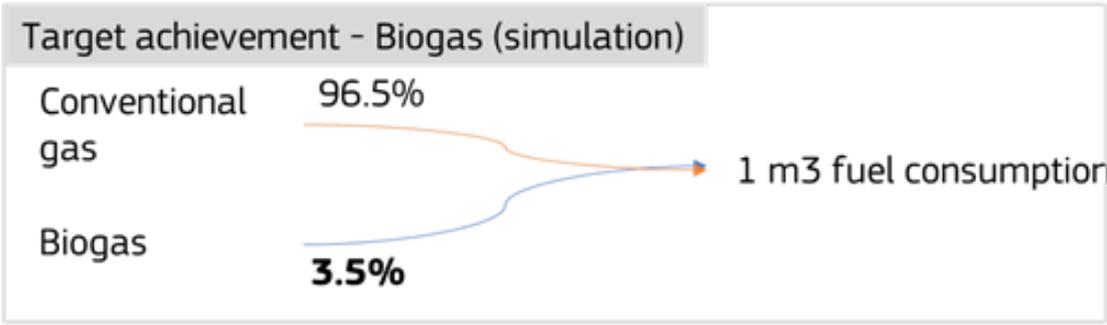
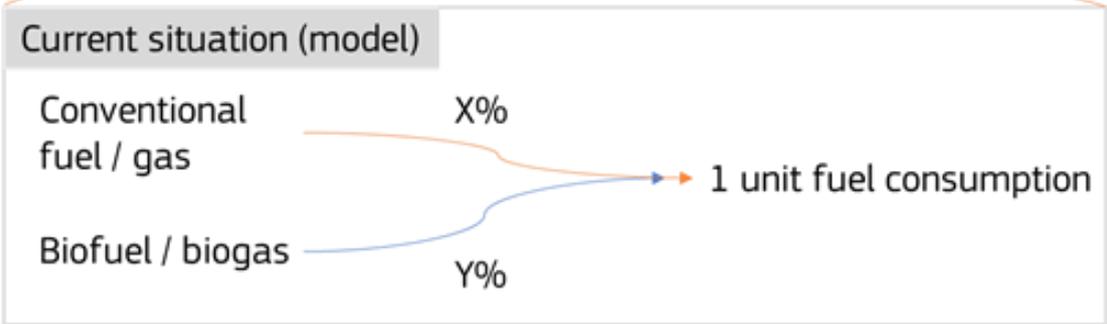
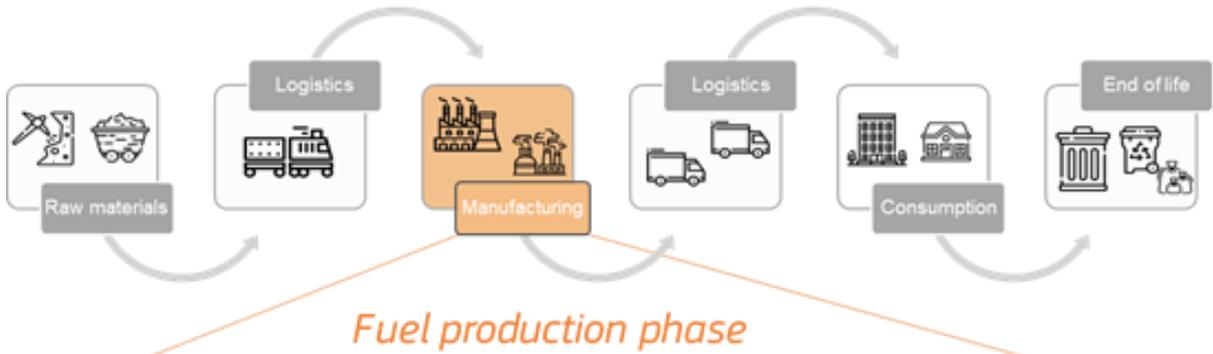
- Biogas: the share is expected to increase over the assessed period, reaching a target of 3.5% by 2030.
- Petrol: the share is expected to increase over the assessed period, bringing the share of biofuel in the current composition (5% traditional biofuel, e.g. E5 fuels) up to 8.5% by 2030.
- Diesel: the share is expected to increase over the assessed period, bringing the share of biofuel in the current composition (7% traditional biofuel, e.g. B7 fuels) up to 10.5% by 2030.

Within the Ecoinvent database, the following processes were selected as advanced biofuels and biogas and combined with the respective fossil-based components:

- Biofuel component in petrol vehicles:
 - Ethanol, without water, in 99.7% solution state, from fermentation, at service station {CH}| market for | APOS, U
- Biofuel component in diesel Vehicles:
 - Ethyl tert-butyl ether {RER}| production, from bioethanol | APOS, U, which includes as main components Ethanol without water in 99.7% solution state from fermentation (47%)
 - Naphtha (53%)
- Biogas components in Compressed Natural Gas Vehicles & Liquefied Natural Gas
 - Biogas | market for biogas | APOS, U, which includes as main components:
 - biogas from anaerobic digestion of manure (32.7%),
 - treatment of biowaste by anaerobic digestion (29.9%),
 - treatment of sewage sludge by anaerobic digestion (37.1%),
 - treatment of used cooking oil by anaerobic digestion (0.3%).

In the model, a combination of market datasets from Switzerland (CH) (55%) and rest of the world (RoW) (45%)¹⁵ is used, based on IEA data.

¹⁵ The share of biogas market between CH and RoW market based on IEA data from [An introduction to biogas and biomethane – Outlook for biogas and biomethane: Prospects for organic growth – Analysis - IEA](#)



Source JRC Elaboration

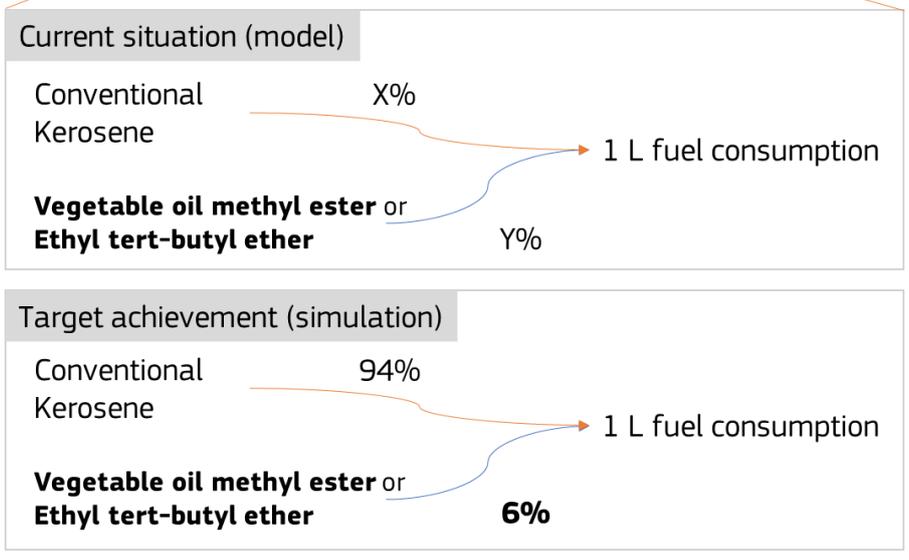
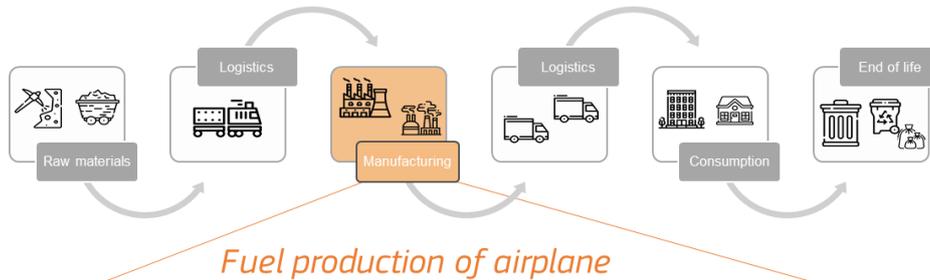
Bio-kerosene

Policy context	
Target(s)	<ul style="list-style-type: none"> — Starting from 2025, at least 2% of aviation fuels will be green, with this share increasing every five years: 6% in 2030, 20% in 2035, 34% in 2040, 42% in 2045 and 70% in 2050. Hydrogen and fuel produced from cooking oil or waste gases considered green (link agreement Council and Parliament on 25.04.2023). — Synthetic aviation fuels are expected to play a role in the decarbonisation of the sector already by 2030 and should contribute to at least 35% of the aviation fuel mix by 2050, according to the EC proposal for ReFuelEU Aviation. <p><i>(Reference year for expansion: 2030)</i></p>
Key policy document	— Proposal for a Regulation on ensuring a level playing field for sustainable air transport (EPC, 2023b)
Target type	Legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Area of consumption	Mobility
Product scope	Air mobility
Variable	Share of biokerosene in the overall fuel consumed by airplane
Variable type	Life cycle inventory
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	The selected processes for biokerosene were chosen as proxies for sustainable aviation fuels, owing to the lack of a more suitable Ecoinvent process.
Modelling description	
<p>In the Consumption Footprint model, various types of fuel can be considered to meet the fuel demand of aircraft. To model the increasing uptake of sustainable aviation fuels (SAFs), such as hydrogen and fuel produced from cooking oil or waste gases, which are considered green, for air mobility, the share of SAFs contributing to the total fuel consumption can be adapted to the characteristics of each scenario.</p> <p>The fuel production is modelled by taking into account the consumption of both:</p> <ul style="list-style-type: none"> — conventional fuel (i.e., kerosene) — biokerosene (i.e. vegetable oil, or methyl ether), as representative of SAFs <p>Although the current model assumes that no biofuel is consumed by aircraft, the share of biokerosene is expected to increase over the assessed period, reaching a target of 6% by 2030.</p> <p>Within the Ecoinvent database, the following processes were selected as biokerosene and combined with the respective fossil-based components:</p> <ul style="list-style-type: none"> — <u>Biofuel component 1</u>: Vegetable oil methyl ester (GLO) - market for - APOS, U, including as main components: <ul style="list-style-type: none"> • Vegetable oil methyl ester Esterification of soybean oil APOS, U (<51%) • Vegetable oil methyl ester Esterification of rape oil APOS, U (<49%) • Vegetable oil methyl ester Esterification of palm oil APOS, U (<1%) 	

— Biofuel component 2: Methyl tert-butyl ether (GLO) - market for - APOS, U, including as main components:

- Butadiene (RER) | Market for butadiene | APOS, U (0.653 Kg)
- Methanol (GLO) market for| APOS, U (0.37 kg)

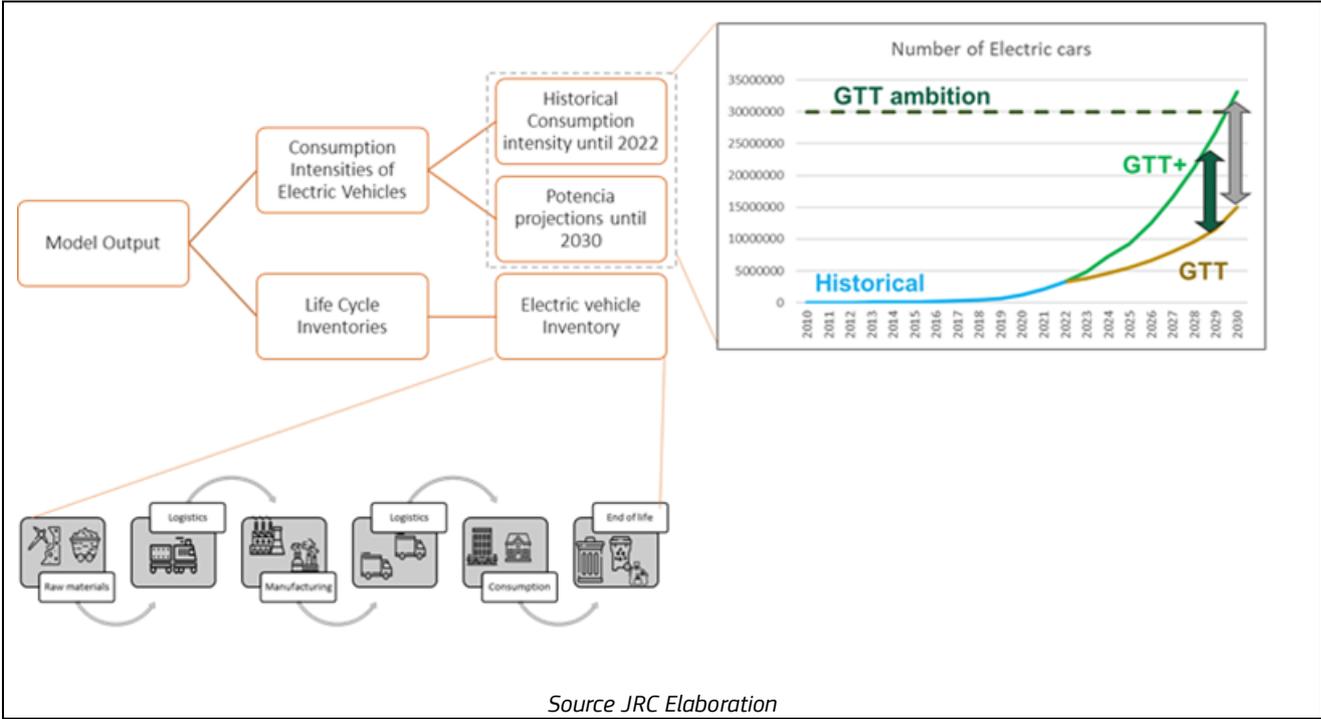
The two identified biofuels were combined at an equal rate (50%-50%).



Source JRC Elaboration

Electric vehicles

Policy context	
Target(s)	— There will be at least 30 million zero-emission cars and 80.000 zero-emission lorries in operation <i>(Reference year for expansion: 2030)</i>
Key policy document	— Sustainable and Smart Mobility Strategy (EC, 2020f)
Target type	Not-legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT+
Technical inputs to modelling	
Area of consumption	Mobility
Product scope	This target affects the consumption intensity of a specific product of Mobility BoP (electric vehicle)
Variable	Consumption of electric vehicles over time, based on Potencia data.
Variable type	Consumption intensity (Vehicle stock)
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations in modelling	As the CF model does not consider heavy-duty transport as a separate vehicle type, but rather as part of the life cycle of each individual product, the second part of the target (zero-emission lorries) was not modelled due to time constraints.
Modelling description	
<p>In the CF model, electric cars are modelled to represent a share of personal car mobility, and this type of technology has been taken into account as 'zero-emission cars' (i.e. hydrogen cars are not considered). For current mobility intensity data, the CF model relies on data from DG MOVE and Eurostat to compile information about the EU vehicle stock and the intensity of mobility per year (i.e. the total kilometres travelled by each vehicle) (Sanyé Mengual et al., 2023).</p> <p>The simulation of the vehicle stock and annual mobility intensity in the GTT+ scenario is based on the projections by 2030 from the Energy model Potencia, as used in the Agricultural Outlook (EC, 2023e). These projections assume that the target of 30 million electric cars sold in 2030 will be achieved, with a total of almost 40 million cars projected.</p>	



Housing

Renewable energy in buildings

Policy context	
Target(s)	<p>— Member States shall determine an indicative national share of renewable energy produced on-site or nearby as well as renewable energy taken from the grid in final energy consumption in their building sector in 2030 that is consistent with an indicative target of at least a 49 % share of energy from renewable sources in the building sector in the Union’s final energy consumption in buildings in 2030</p> <p><i>(Reference year for expansion: 2030)</i></p>
Key policy document	— Directive on energy from renewable sources (EPC, 2023a).
Target type	Legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Area of consumption	Housing
Product scope	This target affects the energy mix of all dwellings.
Variable	Energy mix
Variable type	Background element
Type of edit to the model	Process changes (#2 in Annex 2)
Limitations in modelling	No specific limitations have been identified.
Modelling description	
<p>In the simulations, the shares (and amounts) of energy by source are calculated at the EU level based on Potencia data, as presented in the Agricultural Outlook (EC, 2023e). The granularity of energy sources in Potencia was mapped to the electricity mix granularity in the Consumption Footprint model. Based on the total amount of energy by source, the shares were recalculated to create the 2030 electricity mix. Depending on the scenario and the consideration of individual quantitative targets, the contribution of each energy source to the total electricity production may be altered from the Potencia projections, which assume that all targets will be reached by 2030.</p> <p>This target can be considered as partially achieved due to the addition of the following assumption:</p> <p>— the modelling of a new electricity mix, which is based on the targets for electricity from renewable sources (e.g. by 2030, the share of renewable energy in the electricity mix is expected to double to 55-60%).</p>	

Energy consumption in buildings: heating and cooling, and final energy consumption

Policy context	
Target(s)	<ul style="list-style-type: none"> — Reduce buildings' energy consumption for heating and cooling by 18%¹⁶ — Reduce buildings' final energy consumption by 14% <p>(Reference year for reduction: 2015)</p>
Key policy document	<ul style="list-style-type: none"> — Proposal for a Directive of the European Parliament and of the Council on the Energy Performance of Buildings (recast) (EPC, 2021b) — A Renovation Wave for Europe (EC, 2020e).
Target type	Non-legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT+
Technical inputs to modelling	
Area of consumption	Housing
Product scope	This target affects all dwellings
Variable	Energy consumption
Variable type	Consumption intensity (annual)
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations	No specific limitations have been identified.
Modelling description	
<p>The Consumption Footprint model for the Housing sector calculates the energy consumption by final use (i.e. space heating, cooling, domestic hot water, lighting, and appliances). These targets are modelled by applying an 18% reduction in energy consumption for cooling and heating, and a 14% reduction in total energy consumption in housing. Energy consumption intensities for heating and cooling from 2015 have been used as a reference value. A reduction has been applied to each type of dwelling and projected to the 2030 building stock.</p>	<p>The diagram illustrates the Consumption Footprint model process. It starts with 'Raw materials' (represented by a pickaxe and a pile of rocks), which goes through 'Logistics' (represented by a truck) to 'Manufacturing' (represented by a factory). From 'Manufacturing', it goes through another 'Logistics' step (represented by a truck) to 'Consumption' (represented by a house icon). Finally, it goes to 'End of life' (represented by a recycling bin). Below this flow, two boxes compare the 'Current situation (model)' at 'XX GWh' and the 'Target achievement (simulation)' at 'XX -18%'. An orange arrow labeled 'Energy consumption reduction' points from the current situation to the target achievement.</p>
Source JRC Elaboration	

¹⁶ Compared to 2015 levels (https://eur-lex.europa.eu/resource.html?uri=cellar:0638aa1d-0f02-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF)

Renovation rate in buildings

Policy context											
Target(s)	<ul style="list-style-type: none"> — At least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations — Indicative national targets aiming to achieve the deep renovation of at least 35 million building units by 2030 to support reaching an annual energy renovation rate of 3 % or more for the period till 2050 (<u>see latest test adopted by EP on 14.03.2023</u>) <p><i>(Reference year for expansion: 2020 - this was not mentioned explicitly in the document. It is assumed to be the year of publication of renovation wave)</i></p>										
Key policy document	<ul style="list-style-type: none"> — A Renovation Wave for Europe (EC, 2020e) — Proposal for a Directive on the Energy Performance of Buildings (EPC, 2021b) 										
Target type	Non-legally binding										
Scenario assumptions											
Target reached in scenario(s)	GTT+										
Technical inputs to modelling											
Area of consumption	Housing										
Product scope	This target all dwellings apart from building built after 2010										
Variable	Housing stock										
Variable type	Consumption intensity (annual)										
Type of edit to the model	Changes in parameter values (#1 in Annex 2)										
Limitations in modelling	This target considers only deep renovation.										
Modelling description											
<p>The Consumption Footprint model distinguishes between different dwellings based on the age of their construction, as the materials used (type and quantity) vary. This is particularly relevant to the construction characteristics of buildings that are being targeted for energy efficiency improvements through renovation policies. The energy renovation is achieved by replacing the number of dwellings in the existing stock that were built before 2010 with newer buildings constructed after 2010.</p> <p>The renovation type applied to the model is a deep renovation. To ensure consistency with this assumption, the deep renovation rate for the current situation (as of 2021) is assumed to be 0.2%. The simulation of the target involves an increase in the renovation rate to 1.3%, which corresponds to a linear increase until 2050 in order to achieve the target of 3%.</p>											
<div style="display: flex; justify-content: space-around;"> <table border="1"> <caption>Current situation (model)</caption> <thead> <tr> <th>Year</th> <th>Rate</th> </tr> </thead> <tbody> <tr> <td>2021</td> <td>0.2%</td> </tr> </tbody> </table> <table border="1"> <caption>Target achievement (simulation)</caption> <thead> <tr> <th>Year</th> <th>Rate</th> </tr> </thead> <tbody> <tr> <td>2030</td> <td>1.13%</td> </tr> <tr> <td>2050</td> <td>3%</td> </tr> </tbody> </table> </div> <p style="text-align: center;"><i>(Deep) Renovation rate</i></p>		Year	Rate	2021	0.2%	Year	Rate	2030	1.13%	2050	3%
Year	Rate										
2021	0.2%										
Year	Rate										
2030	1.13%										
2050	3%										
Source JRC Elaboration											

Cross-Cutting: Renewable energy in the electricity mix

Solar and wind energy

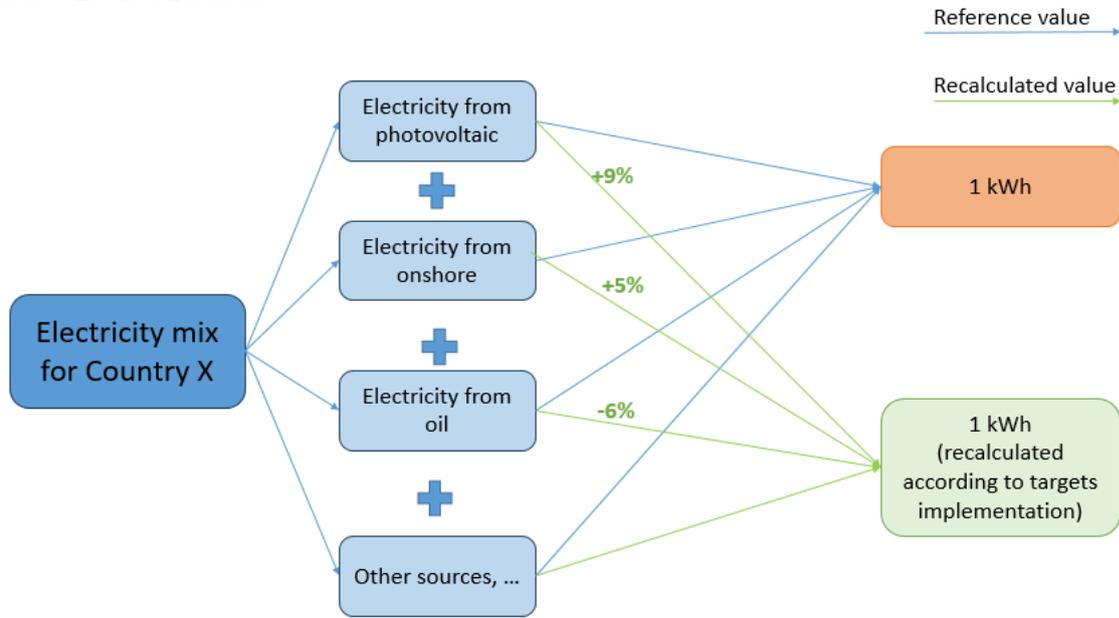
Policy context	
Target(s)	<ul style="list-style-type: none"> — Member States shall collectively ensure that the share of energy from renewable sources in the Union’s gross final consumption of energy in 2030 is at least 42,5 %. — Bring online over 320 GW of solar photovoltaic by 2025 and 600 GW by 2030. — Over this decade, the EU will need to install, on average, approximately 45 GW per year of PV to reach the share of 45% of energy coming from renewables set out in the RePowerEU Plan — By 2030, the share of renewable energy in the electricity mix should double to 55-60%, and projections show a share of around 84% by 2050. The remaining gap should be covered by other low-carbon options — The strategy sets targets for an installed capacity of at least 60 GW of offshore wind by 2030 and at least 300 GW by 2050. — Energy demand to be covered by solar heat and geothermal should at least triple (currently rate at 1,5%) <p><i>(Reference year for expansion: 2030)</i></p>
Key policy documents	<ul style="list-style-type: none"> — EU Solar Energy Strategy (EC, 2022d) — Powering a Climate neutrality economy: An EU Strategy for Energy System Integration (EC, 2020h).
Target type	Non-legally binding
Scenario assumptions	
Target reached in scenario(s)	<ul style="list-style-type: none"> — Offshore wind, geothermal, 55-60% renewables: GTT+ — Other targets: GTT, GTT +
Technical inputs to modelling	
Area of consumption	Food, Mobility, Housing, Appliances, Household goods
Product scope	These target influence all products that use electricity across the life cycle.
Variable (s)	Shares of solar and wind in the electricity mix
Variable type	Life Cycle Inventory (element in the background ¹⁷ inventory)
Type of edit to the model	<ul style="list-style-type: none"> — Changes in parameter values (#1 in Annex 2) — Available modelling exercises (#4 in Annex 2)
Limitations	<p>In the CF model, photovoltaic energy is only produced as low-voltage electricity. The processing and manufacturing stages of many products use electricity at medium voltage, so the update to photovoltaic energy will not have an impact at this stage.</p> <p>Furthermore, the increase in photovoltaic energy production has been modelled only for countries that currently generate energy from offshore sources. No projections or changes have been made for countries that do not currently produce energy from offshore sources.</p>

¹⁷ The Background inventory is intended as a part of the Life Cycle inventory which is embedded among Ecoinvent © or Agribalyse © data which feed the Consumption Footprint model..

Additionally, the increase in offshore energy production has also been modelled only for countries that currently produce energy from offshore sources, with no projections or changes made for countries that do not currently have offshore energy production.

Modelling description

The Consumption Footprint models the electricity mix by combining the production of energy from different energy sources. The share of each energy source is determined based on data from IEA and Eurostat¹⁸.



Source JRC Elaboration

In the simulations, the shares (and amounts) of energy by source are calculated at the EU level based on Potencia data, as presented in the Agricultural Outlook 2023-2035 (EC, 2023e). The granularity of energy sources in Potencia was mapped to the electricity mix granularity in the Consumption Footprint model. Based on the total amount of energy by source, the shares were recalculated to create the 2030 electricity mix. Depending on the scenario and the consideration of individual quantitative targets, the contribution of each energy source to the total electricity production may be altered from the Potencia projections, which assume that all targets will be reached by 2030.

The Ecoinvent process "Electricity, low voltage {Europe without Switzerland} market group for | APOS, U" is currently used as the main electricity mix across all baskets of products (BoPs). This process contains the different shares of the electricity mix at the country level and by energy source. To model all the targets that affect the electricity mix, a new electricity mix has been created for each scenario.

The procedure used to model the new electricity mix and this specific target is based on the following steps:

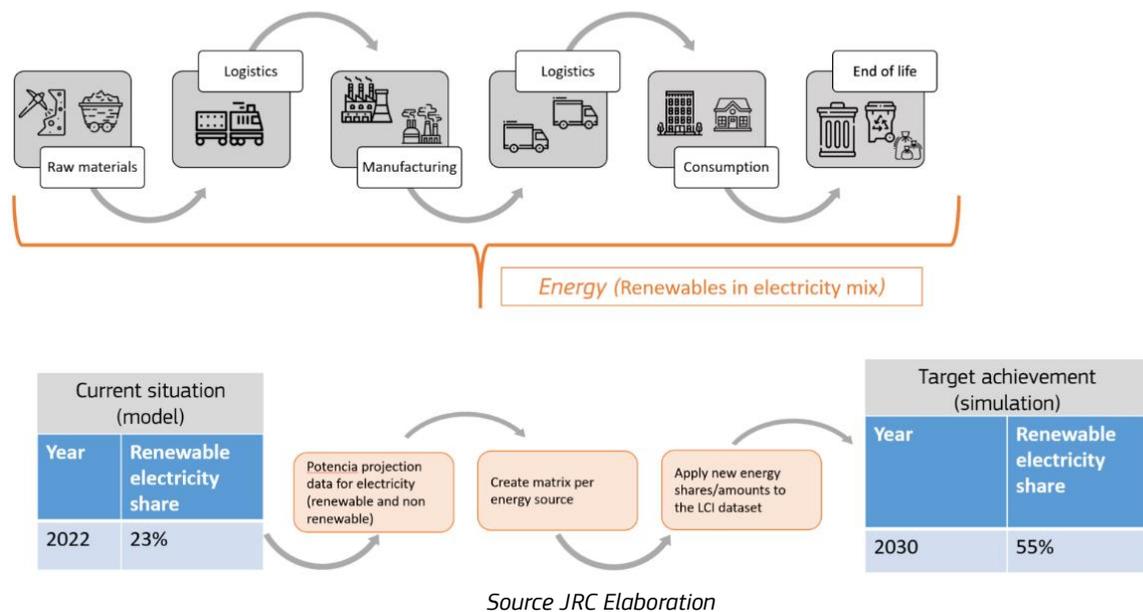
- The electricity mix derived from the CF regionalised model has been used as input data. The CF regionalised model considers the annual electricity mix by country, based on Eurostat and IEA data.

¹⁸ <https://publications.jrc.ec.europa.eu/repository/handle/JRC132734>

- Projections data for 2030 have been calculated based on Potencia projections. Firstly, a mapping between Ecoinvent electricity processes (and Eurostat sources) and Potencia electricity sources has been performed.
- Based on this mapping, projection rates for 2030 have been calculated (at the EU27 level) per each energy source.
- Since this specific target has been considered achieved by Potencia projections as well, the same rate has been used in each scenario (NO GTT, GTT, and GTT+).
- The calculated rates have been applied to each country's electricity mix (in cases where this specific energy source is produced in that country).

For the targets that are not achieved in the GTT+ scenario, different shares have been calculated for the different scenarios. For the NO GTT and GTT scenarios, the Potencia rate has been applied. To simulate the target achievement for the GTT+ scenario, electricity consumption in GWh has been calculated by extrapolating the Potencia conversion factor, and it has been applied to the targeted amount (109 GW).

The Ecoinvent electricity mix considers, for each country, that the total quantity of each electricity mix should sum up to 1 kWh (see image below; please note that the shown percentages are not real, but used only as an example). In cases where the amount of energy produced was higher or lower than 1 kWh, the (eventual) remaining share has been reallocated to the different energy sources according to the previously calculated share. Regarding the amounts of electricity imports, they have not been changed. Electricity losses along the transmission lines have not been changed either.



Cross cutting: Waste treatment

Landfill share

Policy context	
Target(s)	— Reduce landfill to a maximum of 10% of municipal waste (by 2035) <i>(Reference year for reduction: 2020 (this was not mentioned explicitly in the document. It is assumed to be the year of publication of New Circular Economy Action plan))</i>
Key policy document	— A new Circular Economy Action Plan. For a cleaner and more competitive Europe. (EC, 2020b)
Target type	Legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+ (only some countries will be able to reach this target)
Technical inputs to modelling	
Area of consumption	Food, Appliances, Household goods, Housing
Product scope	This target will affect many products in different BoPs (Food, Appliances, Household goods, Mobility)
Variable	Share of landfill in end of life of products
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations	The Consumption Footprint model considers the end of life for packaging as a closed loop system, since all packaging wastes can go to: 1) recycling, 2) landfill, 3) incineration). Since there are targets both for landfill and for recycling, the waste fraction that is deducted from the landfill share is considered to go to incineration.
Modelling description	
<p>The CF model represents the end of life of various representative products, taking into account the proportions of landfill, recycling, and incineration (which vary depending on the product), based on waste treatment statistics and literature.</p> <p>As the target is set for 2035, we have estimated that the expected rate for 2030 will be 13.6%. In scenarios where this target is achieved, the proportion of waste flows into landfill is reduced to the target value (13.6%), while incineration and recycling are increased (in line with other recycling targets, where applicable).</p>	
Source JRC Elaboration	

Cross cutting: Batteries end of life

Recycling waste in batteries: non-lithium batteries

Policy context	
Target(s)	<p>Recycling shall achieve at least the following targets for recycling efficiency:</p> <p>No later than 31 December 2025</p> <ul style="list-style-type: none"> — 75% by average weight of lead-acid batteries; — 80% by average weight of nickel-cadmium batteries — 50% by average weight of other waste batteries <p>No later than 31 December 2030</p> <ul style="list-style-type: none"> — 80% by average weight of lead-acid batteries; <p>Recycling shall achieve at least the following targets for recycling efficiency:</p> <p>No later than 31 December 2025</p> <ul style="list-style-type: none"> — 65% by average weight of lithium-based batteries; <p>No later than 31 December 2030</p> <ul style="list-style-type: none"> — 70% by average weight of lithium-based batteries <p><i>(Reference year for expansion: 2030)</i></p>
Key policy document	— Strategic Action Plan on Batteries and the Circular Economy (EPC, 2023c)
Target type	Legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT +
Technical inputs to modelling	
Area of consumption	Mobility, Appliances
Product scope	Batteries
Variable	Recycling rate
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations	No specific limitations.
Modelling description	
<p>The CF model currently considers the following types of batteries:</p> <ul style="list-style-type: none"> — — Lithium-ion (Li-ion) batteries in the following products: hybrid vehicles, electric vehicles, and mobile phones — — Lead-acid batteries for conventional vehicles <p>The end of life of batteries is modelled, taking into account different waste treatment pathways, including disposal and recycling. This is modelled during the maintenance or end of life of the vehicles.</p> <p>In the case of lead-acid batteries, disposal is part of the "Vehicle Maintenance" process, and it is assumed that all scrap lead-acid batteries are melted down and recycled back into the industry, thereby achieving 100% recycling efficiency.</p>	

Recycling of metals

Policy context	
Target(s)	All recycling shall achieve at least the following targets for recovery of materials: No later than 31 December 2027 — 90% for cobalt, copper, lead and nickel, No later than 31 December 2031: — 95% for cobalt, copper, lead, and nickel <i>(Reference year for expansion: 2030)</i>
Key policy document	— Strategic Action Plan on Batteries and the Circular Economy (EPC, 2023c).
Target type	Legally binding
Scenario information	
Target reached in scenario(s)	GTT, GTT+
Inputs to modelling	
Area of consumption	Cross-cutting
Product scope	Batteries
Variable	Recycling rate
Variable type	Life cycle element
Type of edit to CF	Changes in parameter values (#1 in Annex 2)
Limitations	No specific limitations have been identified.
Modelling description	
<p>Currently, in the CF model, copper, lead, and nickel have a recycling rate of 87%. When modelling the target, this value has been simulated as 95%.</p> <p>The diagram illustrates the metal recycling process. It starts with 'Raw materials' (represented by a pickaxe and a truck), followed by 'Logistics' (represented by a truck), 'Manufacturing' (represented by a factory), another 'Logistics' step (represented by a truck), 'Consumption' (represented by a house and a building), and finally 'End of life' (represented by a trash bin). Below this flowchart, two boxes are shown: 'Current situation (model)' with a blue circle containing '87%' and 'Target achievement (simulation)' with a blue circle containing '95%'. An orange arrow labeled 'Recycling of metals' points from the current situation to the target achievement.</p>	
<i>Source JRC Elaboration</i>	

Cross cutting: Recycling of packaging

Packaging: recyclability

Policy context	
Target(s)	<ul style="list-style-type: none"> — Recycling or preparing for re-use 65% of all packaging waste by 2025, 70% by 2030. — Recycling of aluminium in packaging: 60% — Recycling of ferrous metals in packaging: 80% — Recycling of glass in packaging: 75% — Recycling of paper and cardboard in packaging: 85% — Recycling of wood in packaging: 30% — Recycling of PET bottles — Recycling of plastic in packaging : 55% <p>(Reference year for expansion: 2030)</p>
Key policy document	— Directive on packaging and packaging waste (EC, 2022e).
Target type	Legally binding
Scenario assumptions	
Target reached in scenario(s)	GTT, GTT+
Technical inputs to modelling	
Area of consumption	Food, Appliances, Household goods
Product scope	This target affects all packaging materials, namely plastics, metals and paper/cardboard.
Variable	Recycling rate
Variable type	Life cycle element
Type of edit to the model	Changes in parameter values (#1 in Annex 2)
Limitations	No specific limitations have been identified.
Modelling description	
<p>The CF models the end-of-life stage of various representative products, taking into account the proportions of landfill, recycling, and incineration (which vary depending on the product). This is based on waste treatment statistics and literature.</p> <p>When the target is simulated, a recycling rate of 70 per cent is assumed.</p> <p>Note that this target overlaps with the previous one, and when modelled together, this overlap is not observed as a separate entity.</p>	<p style="text-align: center;"><i>Source JRC Elaboration</i></p>

Annex 5. ZPAP targets for Domestic Footprint

Acidification

The impact category value of 2005 is reduced by 25%.

Climate Change

Climate change is not directly considered among the ZPAP targets; however, it is incorporated as expressed in the document 'Climate Change 2030' (EPC, 2021a). According to this document, the 1990 Climate Change value is reduced by 55%.

The value used for 1990 is:

- $cc_{1990} = 12.80 = (4925 \cdot 10^6) / 384888000$

Ecotoxicity, freshwater

The impact of pesticides and antimicrobials is reduced by 50% using the value of the year 2018 as reference value.

Eutrophication, freshwater

The impact category value of 2005 is reduced by 50%.

Eutrophication, marine

The impact category is reduced considering a 50% reduction of agricultural emissions of nitrogen to water from the reference value of year 2005.

Eutrophication, terrestrial

The impact category value of 2005 is reduced by 20%.

Human toxicity, cancer

The impact of pesticides and antimicrobials is reduced by 50% using the value of the year 2018 as reference value.

Human toxicity, non-cancer

The impact of pesticides and antimicrobials is reduced by 50% using the value of the year 2018 as reference value.

Ionising radiation

No ZPAP target is defined for this impact category.

Land use

No ZPAP target is defined for this impact category.

Ozone depletion

Ozone depletion is not directly addressed by any of the ZPAP targets, primarily because the Montreal Protocol (UNEP, 1987), signed by all EU Member States, has been fulfilled through the prohibition of the most harmful ozone-depleting substances (ODS), such as CFCs and HCFCs. The Montreal Protocol has been strengthened over the years by several amendments (in 1990, 1992, 1997, 1999, and 2016) to enhance its implementation (EPC 2024b). In recent years, increasing attention has been paid to HFCs, which are widely used as substitutes for HCFCs since they do not contribute to ozone depletion. Unfortunately, HFCs have global warming potentials (GWPs).

As no quantitative target has been set by the Montreal Protocol, it has been decided to consider the ozone depletion level in 2015 as the reference year for comparing ozone depletion trends. The year 2015 was chosen because, from 1 January 2015, it became illegal to use any HCFCs for servicing refrigeration and air conditioning equipment (including the use of recycled and reclaimed HCFCs).

The target was reached in 2015, and that value is used as the benchmark.

Particulate matter

The impact category value of 2005 is reduced by 55%.

Photochemical ozone formation

The impact category value of 2005 is reduced by 55%.

Resource use, fossil

No ZPAP target is defined for this impact category.

Resource use, minerals and metals

No ZPAP target is defined for this impact category.

Water use

No ZPAP target is defined for this impact category.

Annex 6. ZPAP targets for Consumption Footprint

Consumption Footprint data are available starting the year 2010. Whenever the specified reference year precedes 2010 (e.g., 2005), we employ a linear regression from the available data going backward to estimate the reference value.

Acidification

The impact category value of 2005 is reduced by 25%.

Climate Change

Climate change is not directly considered among the ZPAP targets; however, it is incorporated as expressed in the document 'Climate Change 2030' (EPC, 2021a). According to this document, the 1990 Climate Change value is reduced by 55%.

The value used for 1990 is:

- $cc_{1990} = 12.80 = (4925 \cdot 10^6) / 384888000$

Ecotoxicity, freshwater

Reduced by modifying inventory parameters.

Freshwater ecotoxicity is influenced by the modelling of ZPAP Target 4 (i.e., “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”), specifically through the **reduction of pesticides**.

ZPAP target 4 is based on the Biodiversity Strategy (EC, 2020a) and Farm to Fork Strategy (EC, 2020d):

- “50% reduction of nutrient losses by 2030. The target shall ensure that there is no deterioration in soil fertility and will lead to 20% reduction of the use of fertilisers.”
- “By 2030, 50% reduction of the overall use and risk of chemical pesticides and 50% reduction of the use of more hazardous pesticides.”
- “50% reduction of overall EU sales of antimicrobials for farmed animals and in aquaculture by 2030.”

The ZPAP target has been modelled by applying the following reduction parameters:

- A 50% reduction at the production and application level for pesticides, as well as pesticide packaging and application methods.
- A 20% reduction applied at the production and application level for fertilisers, as well as fertiliser packaging and application methods.
- A 50% reduction in emissions associated with fertiliser application.

Eutrophication, freshwater

Reduced by modifying inventory parameters.

Freshwater eutrophication is influenced by the modelling of **ZPAP Target 4**: “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”, specifically by **nutrient loss and fertilizers reduction**.

ZPAP target 4 is based on the Biodiversity Strategy (EC, 2020a) and Farm to Fork Strategy (EC, 2020d):

- “50% reduction of nutrient losses by 2030. The target shall ensure that there is no deterioration in soil fertility and will lead to 20% reduction of the use of fertilisers.”
- “By 2030, 50% reduction of the overall use and risk of chemical pesticides and 50% reduction of the use of more hazardous pesticides.”
- “50% reduction of overall EU sales of antimicrobials for farmed animals and in aquaculture by 2030.”

The ZPAP target has been modelled by applying the following reduction parameters:

- 50% reduction at production and application level for pesticide as well as pesticide packaging and application method.
- 20% reduction applied at production and application level for fertilizer as well as fertilizer packaging and application method.
- 50% reduction of emissions associated with fertilizer application.

Eutrophication, marine

Reduced by modifying inventory parameters.

Marine eutrophication influenced by the modelling of **ZPAP Target 4**: “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”, specifically by **nutrient loss and fertilizers reduction**.

ZPAP target 4 is based on the Biodiversity Strategy (EC, 2020a) and Farm to Fork Strategy (EC, 2020d):

- “50% reduction of nutrient losses by 2030. The target shall ensure that there is no deterioration in soil fertility and will lead to 20% reduction of the use of fertilisers.”
- “By 2030, 50% reduction of the overall use and risk of chemical pesticides and 50% reduction of the use of more hazardous pesticides.”
- “50% reduction of overall EU sales of antimicrobials for farmed animals and in aquaculture by 2030.”

The ZPAP target has been modelled by applying the following reduction parameters:

- 50% reduction at production and application level for pesticide as well as pesticide packaging and application method.
- 20% reduction applied at production and application level for fertilizer as well as fertilizer packaging and application method.

- 50% reduction of emissions associated with fertilizer application.

Eutrophication, terrestrial

Reduced by modifying inventory parameters.

Terrestrial eutrophication is influenced by the modelling of **ZPAP Target 4**: “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”, specifically by **nutrient loss and fertilizers reduction**.

ZPAP target 4 is based on the Biodiversity Strategy (EC, 2020a) and Farm to Fork Strategy (EC, 2020d):

- “50% reduction of nutrient losses by 2030. The target shall ensure that there is no deterioration in soil fertility and will lead to 20% reduction of the use of fertilisers.”
- “By 2030, 50% reduction of the overall use and risk of chemical pesticides and 50% reduction of the use of more hazardous pesticides.”
- “50% reduction of overall EU sales of antimicrobials for farmed animals and in aquaculture by 2030.”

The ZPAP target has been modelled by applying the following reduction parameters:

- 50% reduction at production and application level for pesticide as well as pesticide packaging and application method.
- 20% reduction applied at production and application level for fertilizer as well as fertilizer packaging and application method.
- 50% reduction of emissions associated with fertilizer application.

Human toxicity, cancer

Reduced by modifying inventory parameters.

The cancer related human toxicity is primarily influenced by the **reduction of pesticides** modelled for **ZPAP Target 4**: “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”, specifically by nutrient loss and fertilizers reduction.

Human toxicity, non-cancer

Reduced by modifying inventory parameters.

The non-cancer related human toxicity is primarily influenced by the **reduction of pesticides** modelled for **ZPAP Target 4**: “By 2030 the EU should reduce by 50% nutrient losses, the use and risk of chemical pesticides and the use of the more hazardous ones, and the sale of antimicrobials for farmed animals and in aquaculture”, more specifically by nutrient loss and fertilizers reduction.

Ionising radiation

No ZPAP target is defined for this impact category.

Land use

No ZPAP target is defined for this impact category.

Ozone depletion

The target was reached in 2015, and that value is used.

Particulate matter

The impact category value of 2005 is reduced by 55%.

Photochemical ozone formation

The impact category value of 2005 is reduced by 55%.

Resource use, fossil

No ZPAP target is defined for this impact category.

Resource use, minerals and metals

No ZPAP target is defined for this impact category.

Water use

No ZPAP target is defined for this impact category.

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