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Report on ex ante impact assessment

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Summary

By use of macro-economic model EXIOMOD, the expected impacts of actions described in the Strategic Research and Innovation Agenda (SRIA) have been analyzed. The results of this analysis show that the R&I actions described in the SRIA contribute to decoupling economic growth from resource use. The actions are expected to cause an increasing gross domestic product and a decreasing raw material demand. This results in an increasing extracted resource productivity, a measure used to show the decoupling of economic growth and resource use. It can however be questioned whether the actions in the SRIA - or the measures implemented in the model - assume a strong enough pace for decoupling economic growth and material use. The actions contribute to the climate goals of the European Commission, by showing a pathway through which the emissions of greenhouse gas can be reduced.

Approval

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Definitions and acronyms

BAU: Business as usual scenario.

CGEM: Computational General Equilibrium Model. GCE models are simulations that look at the economy as a complete system of inter-dependent components (industries, households, investors, governments, importers and exporters). The model includes behaviour functions which describe and identify economic behaviour of agents, faced by technological and institutional constraints.

Consumption based emissions: Consumption based emissions reflect all emissions that a region is responsible for due to its final consumption (of e.g. households and governments). This definition includes all emissions emitted during the full value chain of goods purchased in that region. This definition of emissions is corrected for trade. For example, assume a simplified value chain of a car that has been purchased in Germany. The car was manufactured in France, France imported the tires from Spain and the metal from China, and Spain imported rubber from Indonesia. Consumption based emissions are all emissions emitted at any moment of the production process of that vehicle purchased by a German end user.

Consumption based material use: Total material extracted for all products purchased by final users in a regions. Final users include households and governments.

DEU: Domestic Extraction Used refers to the flows of raw materials extracted or harvested from the environment and that physically enter the economic system for further processing or direct consumption (they are used by the economy as material factor inputs)[1].

DMC: Domestic material consumption is defined by "the total amount of materials directly used by an economy", or "the annual quantity of raw materials extracted from the domestic territory, plus all physical imports, minus all physical exports"[2].

EXIOBASE: Database used in the current version of EXIOMOD. It is a Multi-Regional Environmentally Extended Supply and Use (SU)/ Input-output (IO) database. This database has been developed by harmonizing and increasing the sectorial disaggregation of national SU and IO tables for a large number of countries, estimating emissions and resource extractions by industry, harmonizing trade flows between countries per type of commodities. *(For more information, see IO-model and SUT.)*

EXIOMOD: EXtented Input-Output MODel. "Extended" refers to the fact that EXIOMOD can extend the standard Input-Output analysis in two main directions: (1) to CGEM analysis (2) to specific topics such as environmental impacts, energy or transports. *(For more information see IO-model and GCEM.)*

Final demand emissions: Emissions emitted during the final consumption of goods by households or governments. Thus, not during a production process. Final demand emissions are part of consumption based emissions, as well as production based emissions.

GCEM: General Computational Equilibrium Model. This is a class of macro-economic models that calculates the economic impact and ripple effects of positive or negative economic shocks. These shocks can be behavioural changes, policy decisions like tax raises. Contrary to IO-models, GCEM take

[1] Definition OECD
[2] Definition Eurostat website.

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price changes into account. In general, a GCEM model finds an equilibrium under the condition that total demand equals total supply.

GDP: Gross Domestic Product. Gross domestic product is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on product groups not included in the value of their outputs). The sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services, or the sum of primary incomes distributed by resident producer units[3]. The two ways of calculating the GDP should match by definition.

GHG: Greenhouse gas Emissions. For the analysis of this report, it is equal to carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).

IO-model: input-output model. This is a macro-economic analysis that is in general used to calculate multipliers (e.g. by how much increases total economy when increasing final consumption with one extra euro).

JP: Joint Programme. SRIA consists of 4 Joint Programmes, 'Circular Cities', 'Circular Industries', 'Closing the Loop', and 'Resource Efficiency on Territory and Sea'. The four joint programmes provide a framework for a more systemic innovation aiming to create holistic, cross-cutting and systemic programmes with greater impacts.

LES-CES function: Linear Expenditure System-Constant Elasticity of Substitution as part of a GCEM. Allows households to differentiate between necessity and luxury products. This function defines a subsistence level for each good consumed which lead to an elasticity between consumption and revenue lower than one. For instance for food we have a high subsistence level, whereas for other products consumption is more sensitive to the level of income.

Production based emissions: Emissions are in general measured base on this definition. It is the total amount of emissions emitted within the territory of a region.

Production based material use: Total material extracted in the production process of industries in a certain region. This is total material extracted within the territory of a region. Production based material use is in fact equal to Domestic Extraction Used.

Rebound effect: Concept used in energy-economy, referring to an energy efficiency improvement that results in a smaller decrease in fuel consumption as might be expected from the efficiency. Rebound effects arise for instance when consumers spend the saved money on energy-consuming products.

Relative competitiveness: a relative competitiveness indicator is developed to highlight the impact of the policy scenarios on the competitive position of a region. It answers the question: are the product prices in a certain region competitive with the product prices of imported products from foreign competitors?

Extracted Resource Productivity: The definition of resource productivity (ERP) is gross domestic product (GDP) divided by Domestic Extracted Used (DEU): ERP=GDP/DEU For the definition of DEU, see DEU.

[3] Definition OECD website.

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SRIA: "Strategic Research and Innovation Agenda on Circular Economy."

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Executive Summary

Our own economy and the developing economies globally require vast amounts of materials leading to environmental pressures beyond the carrying capacity of the world. In order to further develop a thriving economy globally that stays within the limits of our globe, we must quickly start the transformation towards a system that reduces consumption for instance by increasing re-use, increasing lifetime of goods and increased recycling (MacArthur, 2013). This is a complex challenge. For a successful transition, adequate policies need to be adopted and innovative technologies have to be developed and implemented. This transition can therefore not be achieved without the support and funding from national governments and the European Commission.

With funding from the European Commission, project CICERONE was launched. The goal of this project is to develop a platform for EU program owners to coordinate and collaborate on priority research and innovation (R&I) actions on circular economy. Part of this process was the development of the circular economy strategic research and innovation agenda (SRIA). It answers the question: which innovations and research are needed to accelerate the circular economy? The SRIA contains four *joint programs*, which shape the innovation fields into structured and strategic R&I programs: 'Circular Cities' , 'Circular Industries', 'Closing the Loop' and 'Resource Efficiency on Territory and Sea'.

However, the actions defined in the SRIA call for a need to understand potential future impact of these actions on economy and environment, which is the objective of this report. What is the expected contribution of SRIA on the reduction of primary material use, reduction of emissions and inclusive growth? To what extent will the SRIA affect the competitive position of the EU.

The scenarios will be assessed by using the macro-economic model EXIOMOD that is built on top of the EXIOBASE database. This model connects domestic consumption and production with trade, materials flows and environmental extensions for a multitude of regions, including four EU-regions. The analysis results in a set of impacts, including environmental (e.g. footprints), economic (e.g. GDP) and social (e.g. employment) impacts due to the SRIA. The impacts have been calculated up to the year 2030.

The results of this analysis show that the R&I actions described in the SRIA contribute to decoupling economic growth from resource use. The actions are expected to cause an increasing gross domestic product and a decreasing raw material demand. This results in an increasing extracted resource productivity, a measure used to show the decoupling of economic growth and resource use. It can however be questioned whether the actions in the SRIA – or the measures implemented in the model – assume a strong enough pace for decoupling economic growth and material use. The actions contribute to the climate goals of the European Commission, by showing a pathway through which the emissions of greenhouse gas can be reduced.

We will shortly explain the different impacts of the actions described in the SRIA. As explained in the report, it is assumed that the actions are described such that they contribute to reaching the goals set by national governments and the European Commission.

The actions in the SRIA have a positive impact on gross domestic product. The increase in GDP is for a large part due to the actions that belong to 'Circular Industries'. Some actions result in measures that cause efficiencies in the industries. Energy efficiency measures and reduction of use of materials

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by re-using or leasing the materials cause efficiencies in these industries. This is in turn beneficial for the profitability of these industries, and causes GDP to increase.

All Joint programs contribute to diminishing raw material use. The report distinguished five types of raw material: wood, other biomass, fossil fuels, non-metallic minerals and metals. Especially the extraction of non-metallic minerals and metals is expected to decrease due to the R&I actions described in the SRIA. Extraction of these materials decreases – depending on the region – between 22%-42% in 2030 compared to the business-as-usual situation in 2030.

The actions in the SRIA cause a larger demand for secondary materials. For secondary materials, data for four material types for the base year has been extracted from Eurostat: biomass, fossil fuels, non-metallic minerals and metals. Especially demand for non-metallic minerals and metals shall increase. This is due to the actions that assume industries should reduce the input of primary raw materials in production processes and replaced this input by secondary materials. Various that contribute to this result, such as urban mining, reduction of urban and industrial waste, reduction of use of primary raw materials.

Extracted Resource Productivity is expected to increase in the scenario where the SRIA is implemented. Extracted Resource Productivity is the ratio of economic welfare over materials extracted. A higher extracted resource productivity is therefore a desired situation, since with the same material input a higher economic growth can be achieved. Similarly, the same economic growth can be achieved with less use of material.

There is some job creation due to the actions described in the SRIA. More important, jobs are expected to shift among the industries. Some sectors diminish in size and are therefore expected to lose jobs and other are expected to be winners due the described actions. Extra jobs are created in industries that focus on leasing activities, reprocessing of secondary materials, renewable energy industry. Industries where jobs are lost are those industries that are dependent on extraction of raw materials, or electricity generated by fossil fuels. Also jobs related to meat production shall diminish over time according to our analysis.

Greenhouse gas emissions will be reduced due to the energy efficiency measures and the shift towards renewable energy. The SRIA places the focus on the decoupling of economic growth from raw materials, but there are also some measures implemented specifically to ensure that we are also going in the right direction for the climate agreements made in Paris. We find that greenhouse gas emissions are about 30% lower in 2030 in the scenario where all joint program actions are implemented compared to the baseline.

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1. Description of Strategic Research and Innovation Agenda (SRIA)

The Strategic Research and Innovation Agenda (SRIA) addresses the needs and priorities for circular economy development in the EU. It is intended to be used as a guiding framework for research and innovation funding agencies, to collaborate and jointly implement circular economy programmes in the EU. For this, priorities are assigned to four Joint Programmes: 'Circular Cities', 'Circular Industries', 'Closing the Loop', and 'Resource Efficiency on Territory and Sea'.

The objective of this report is to understand potential future impacts of the priorities described in the SRIA on economy and environment. What is the expected contribution of SRIA on the reduction of primary material use, reduction of emissions and inclusive growth? To what extent will the SRIA affect the circular economy in each country? In order to answer these questions, we will first clarify which priorities are included in the SRIA.

This section presents a brief description of the content of the four joint programmes of the SRIA. For the full report we refer to (CICERONE, 2020).[4]

1.1 Circular Cities

The goal of this joint programme is to facilitate and promote the transition to a circular economy in urban areas in line with existing sustainable urban development initiatives. Examples of such initiatives are JPI Urban Europe, EU Green Deal or EU CEAP. This requires rethinking how we use different products, services, and materials, but also involve and engage citizens. The Joint Programme 'Circular Cities' aims to still create value while addressing the urban challenges of today.

The objectives, subprogrammes and activities under 'Circular Cities' can be found in Table 1 and Table 2.

Table 1 Circular Cities: subprogrammes and activities for objective A.

Objective A: To enable urban circularity and increasing citizen engagement in circular solutions	
Subprogramme	*Activity name and description*
A1 Infrastructure to enable circular material and product flows	A1.1 Technical development and digitalisation of waste systems A1.2 Improved collection systems for reuse, remanufacturing and sharing A1.3 Planning and design for reuse and recycling
A2 Citizen participation in circular material and product flows	A2.1 Analysis of the current situation on inefficiencies and opportunities for waste collection and recycling A2.2 Coordination and implementation of citizen engagement in waste sorting and collection for target waste streams A2.3 Analysis of social and behavioural barriers for consumers and citizens for systemic transition to circular economy A2.4 Coordination to scale up existing repair and reuse stations (physical and digital) A2.5 Product design that facilitates use-life extension and consumer involvement A2.6 Development of innovative inclusive governance approaches on citizen participation
A3 Enhancing material efficiency and circular	A3.1 Review of packaging-free and reduced packaging businesses and good practices/cases

[4] Text in this section is copied from the SRIA with permission from the authors of the SRIA.

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flows in the food and food packaging sector	A3.2 Analysis of new future-proof food and nutrition concepts from the resource efficiency and food security perspective A3.3 Upscaling recommercialisation and valorisation of commercial and agricultural food waste A3.4 Coordination to scale up recycled/reusable food packaging and packaging-free/reduced packaging (where appropriate)

Table 2 Circular Cities: subprogrammes and activities for objective B.

Objective B: To enhance circular economy and natural resource management in urban areas	
Subprogramme	*Activity name and description*
B1 Circular economy considerations of water and soil in food systems	B1.1 Scaling up organic waste collection, diversion from landfills and reuse for energy and food production (soil nutrient cycling and replenishment) B1.2 Scaling up wastewater recovery and recycling for irrigation and food production B1.3 Mapping of food systems in the EU to identify opportunities for circularity
B2 Circular economy in land and soil resources in construction and urban planning	B2.1 Overcoming barriers to scale up brownfield development and land reuse B.2.2 Scaling up of reusing private and public spaces B2.3 Circular economy in urban transport systems B2.4 Urban farming to provide ecosystem services, food, water storage and cooling, climate mitigation/adaptation B2.5 Historical cultural heritage and natural capital enhancement
B3 Circular economy considerations in water supply and treatment systems	B3.1 Market introduction of existing pilots and demonstration initiatives on water cascading, wastewater reuse and nutrient recycling B3.2 Water type separation and infrastructural changes to water supply and treatment systems
B4 Shifting towards circular water systems in buildings	B4.1 Review of integrated water resource management (IWRM) and innovative water efficiency cases in commercial and residential buildings B4.2 Engaging citizens in scaling up integrated water management in buildings/local level B4.3 Engagement of citizens in integrated water resources management in new urban development

1.2 Circular Industries

The goal of this joint program is to facilitate the transition of industries to the circular economy through research and innovation. It does so in line with The European Green Deal.
The activities identified in this joint program concern innovation in product design, production processes, the efficient use and management of resources, reduction of emissions and waste, valorization of process waste, collaborative exchange between different industries and cross-sector collaboration (e.g. through industrial symbiosis), sustainable and circular management of industrial areas, redevelopment of industrial areas and the conversion of existing factories to the circular economy.
The potential for self-sufficiency is part of the pilot joint calls in the SRIA. In the 'Circular Industries' joint program, this is addressed by industrial symbiosis-related activities.

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The objectives, subprograms and activities under 'Circular Industries' can be found in Table 3, Table 4, Table 5 and Table 6.

Table 3 Circular Industries: subprogrammes and activities for objective A.

Objective A: To develop new technologies, processes, quality standards and analytic methods for new materials production and for resource and waste characterisation	
Subprogramme	*Activity name and description*
Subprogramme A1: Developing new technologies for new materials production	A1.1 Development of innovative biotechnological processes for chemicals production A1.2 Pilot, demonstration and upscaling of innovative biotechnological processes for chemicals production A1.3 Development of innovative biotechnological processes for plastics production A1.4 Pilot, demonstration and upscaling of innovative biotechnological processes for plastics production A1.5 Developing processes and eco-design to substitute hazardous substances A1.6 Pilot, demonstration and upscaling of hazardous substance management in new materials production
Subprogramme A2: Developing quality standards and analytic methods for materials production and characterization	A2.1 Promotion of traceability A2.2 Chemical footprint considerations at the front end of business innovation A2.3 Developing non-destructive analytical methods to achieve better knowledge of materials composition and properties A2.4 Upscaling the use of new analytical techniques and instruments for characterization A2.5 Expansion of extended producer responsibility systems to other sectors
Subprogramme A3: Developing new technologies for resource and waste characterization	A3.1 Upscaling systems for widescale secondary raw material use A3.2 R&D in analytical chemistry and in electronics focused on instrumental analysis A3.3 Development of cost-efficient extractive and processing technologies for improved separation of by-products of ore mining in the EU within the supply chain of materials in CE A3.4 Scale up the use of new analytical instrumental technique for characterization A3.5 New agile processing technologies that adaptively operate within a robust smelter system

Table 4 Circular Industries: subprogrammes and activities for objective B.

Objective B: To enable industrial symbiosis networks and foster digitalisation to master the complexity of products, processes and systems	
Subprogramme	*Activity name and description*
Subprogramme B1: Smart Factories - Building SME partnerships, "alliances of interests" and industrial symbiosis networks	B1.1 Efficient secondary resources information sharing B1.2 Digitalization of SMEs for circular economy B1.3 Development of infrastructure and facilities to upscale industrial symbiosis

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Table 5 Circular Industries: subprogrammes and activities for objective C.

Objective C: To raise awareness of industrial ecology by promoting new/better design and use of products and better re-use of materials already in circulation	
Subprogramme C.1: Promoting eco-design and eco-processes	C1.1 Eco-design and processes that minimise product environmental C1.2 Upscaling of production based on renewable sources Year 5-10 C1.3 Advanced remanufacturing processes for safe and efficient material recovery
Subprogramme C2: Promoting re-use, repair and remanufacturing	C2.1 Development of reverse logistics systems C2.2 Standardisation of components C2.3 Advanced remanufacturing processes for safe and efficient material recovery

Table 6 Circular Industries: subprogrammes and activities for objective D.

Objective D: To reduce the carbon emissions of companies	
Subprogramme D1: Greenhouse gas accounting and management system (individual company*)	D1.1 Development of GHG accounting or inventory systems D1.2 Development of GHG management systems
Subprogramme D2: Promoting secondary raw materials market and industry	D2.1 Technologies for e-waste dismantling, separation and recycling D2.2 Establishment of secondary market platforms for product reuse D2.3 Improvement of e-waste collection infrastructure D2.4 Separation technologies for food contact plastic D2.5 Establishment of secondary market platforms for raw materials
Subprogramme D3: Reducing the carbon and GHG emissions in industrial systems	D3.1 Promote the adoption of simulation and modelling tool for assessing carbon footprint D3.2 Upscaling energy use efficiency measures D3.3 Foster renewable power source Year 5-10 D3.4 Develop technologies for capturing, storage and disposal of GHG D3.5 Promotion of CO_2 utilisation technologies

1.3 Closing the Loop

Closing the loop in production and manufacturing is a key factor to promote the transition to a circular economy, in line with the new EU Circular Economy Action Plan. This is relevant for both materials (e.g. critical raw materials) and products (e.g. plastic packaging, WEEE and tyres), as well as in specific supply chains (e.g. buildings, agro-industry, textiles). Within this challenge all value chain phases need to be taken into consideration: design, material supply and production, consumption and distribution, maintenance, repair and end of life as new production of materials. This type of challenge has itself a wide territorial extension that is typically on the national and global scales (depending on the geographical area of supply for primary resources).

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This joint programme focuses on the implementation of synergic actions at macro level involving all the actors of the value chain (designer, producer, distributor, user, end of life manager, recycler) in order to identify barriers and remove bottlenecks and broken rings hindering the closure of production loops and implement a sustainable system for all the actors involved. Private actors are also highly relevant, and a possible way for engage them is the activation of Public-Private-People Partnership.

Table 7 Closing the Loop: subprogrammes and activities for objective A.

Objective A: To ensure that the manufacturing partnerships in Horizon Europe focus on key priorities in circular economy	
Subprogramme A1: Circular complex product design	A1.1 Analysis of composition and assembly technologies for different existing complex products A1.2 Evaluation of secondary resources as raw materials for complex products A1.3 Design of complex products for recycling and reuse A1.4 Building and testing of pilot plants
Subprogramme A2: Circular business model strategies for complex products	A2.1 Downgrade materials analysis A2.2 Circular business models development A2.3 Testing of circular business models

Table 8 Closing the Loop: subprogrammes and activities for objective B.

Objective B: To address toxic / hazardous substances to human and environmental health in the context of circular economy	
Subprogramme B1: Circular design and technical development for human and environmental health	B1.1 Improvement of existing technologies for detecting and separating hazardous materials B1.2 Development of new technologies for detecting and separating of hazardous materials B1.3 Scaling-up of technologies for detecting and separating hazardous materials B1.4 Circular safety design B1.5 Traceability systems for communicating chemicals of concern in products B1.6 Circular business models for human and environmental health

Table 9 Closing the Loop: subprogrammes and activities for objective C.

Objective C: To elaborate and stimulate the adoption of new policies, standard and protocols for governance resource management systems, fostering inter-stakeholder collaboration and integrated management in the entire value chain	
Subprogramme C1: Traceability and management of raw materials to support governance and standardisation	C1.1 Flow analysis of critical and non-critical raw materials C1.2 European database of raw materials building on suitable IT support C1.3 European database of raw materials at regional level
Subprogramme C2: Promoting market viable solutions for circular economy	C2.1 Materials and sectors analysis C2.2 European industrial symbiosis platform (data) C2.3 European industrial symbiosis platform (instrument)

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1.4 Resource Efficiency on Territory and Sea

The joint programme 'Resource Efficiency on Territory and Sea' focusses on the application of circular economy to the relationships between territory and sea. The joint programme is in line with other initiatives such as the emerging Blue Economy principles and the Blue Growth perspective. This joint programme aims to promote sustainable maritime transport and efficient resource use in ports and coastal areas.

Table 10 Resource Efficiency on Territory and Sea: subprogrammes and activities for objective A.

Objective A: Designing and promoting sustainable maritime transport	
Subprogramme A1: Transitioning to a circular and sustainable shipping industry	A1.1 Development of eco-design approaches for the watercraft production industry A1.2 Development of solutions for electric vessels in maritime transport and upscaling of cold ironing at port areas A1.3 Development and market upscaling of innovative recyclable composite materials and 3D printing in the watercraft industry

Table 11 Resource Efficiency on Territory and Sea: subprogrammes and activities for objective B.

Objective B: Promoting efficient resource use in ports and coastal areas with a long-term perspective	
Subprogramme B1: Transitioning to integrated resource management approaches working at the territorial level with a holistic and circular perspective	B1.1 Design and implementation of industrial symbiosis platforms for discards and waste valorisation at ports (in connection with coastal cities) B1.2 Calculation models to design (mainly nature-based) climate change adaptation actions in ports and coastal cities Year 5-10 B1.3 Material flow analysis with a life cycle perspective at ports and coastal cities B1.4 Innovation hubs in to foster circular economy in port areas and engagement with coastal cities B1.5 Circular and sustainable tourism certification schemes
Subprogramme B2: Transitioning to a sustainable fishing and circular aquaculture sector	B2.1 Valorisation of fish species with commercialisation and sustainable extraction potential Year 5-10 B2.2 Valorisation of seafood by-products and promoting industrial symbiosis in the fisheries sector B2.3 Implementation of sustainable multitrophic aquaculture processes in the appropriate marine areas

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2. Methods

In this section the methods for calculating the impact of the SRIA are explained. The objectives from the SRIA, as presented in the previous section, are quantified. For this, several sources, such as targets from Directives from the European Parliament, are used. The quantification of objectives is discussed in Section 2.1. These quantifications are bundled in order to create scenarios which model the impact of the joint programmes. A qualitative description of these scenarios is presented in Section 2.2. These qualitative descriptions are convenient to use as handhold in the clarification of the results for each Joint Program. Section 2.3 gives a general description of EXIOMOD, the model used to calculate the impact of the SRIA. Section 2.4 discusses EXIOMOD model assumptions specifically for CICERONE.

2.1 Quantification of objectives

The aim of this report is to show the potential future impact of the SRIA on the economy and environment. The objectives, subprogrammes and defined actions under the Joint Programmes are described in a qualitative manner. This is illustrated in Table 1 and Table 2. For example, action "A1.3 Planning and design for reuse and recycling" does not give an indication of which percentage should be recycled or reused for certain materials. This information is essential when using a quantitative macro-economic model to understand the possible future impacts of these objectives on the economy and environment.

Therefore, a translation step between the objectives described in the SRIA and the quantitative input for the macro-economic model is required. For this, a literature review has been performed to connect the subprogrammes of the SRIA to relevant quantitative model input. Quantified goals defined in the Circular Economy action plan have been used, but also model input of previous EU funded projects or national quantitative goals are used for the quantification.

Underlying to the quantification of the SRIA is the assumption that innovative actions will reach a certain goal. For example, Subprogramme A1 is defined as "Infrastructure to enable circular material and product flows". The description of this subprogramme includes "*…facilitate increased citizen participation in circular material and product flows.*" and "*Special focus is required for the planning and design of construction and demolition (C&D) materials in order to increase reuse/recycling*". Thus, this subprogramme aims to increase recycling and reuse of products and materials. For quantification, a recycling and reuse target has been connected to this subprogramme.

For example, for Subprogramme A1, the targets are found in Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste (European Commission, 2018b):

> Member States shall take the necessary measures designed to achieve the following targets:
> - by 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55 % by weight;
> - by 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60 % by weight;
> - by 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65 % by weight.

For construction and demolition waste (CDW) the following targets are given by the (European Commission, 2019):

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- In 2020 70% C&D waste "shall be prepared for re-use, recycled or undergo other material recovery" - In 2030 we put the same goal to 90% (some countries already had this in 2011, although that was including backfilling)

In order to quantify, it is assumed that subprogramme A1 will contribute to reaching these goals.

Also, we should point out that some of the objectives described by the SRIA are either quite general or are on a topic that cannot be implemented in an economic model. In these situations, it is difficult to reason a sensible quantification attached to this objective. General objectives have for example a low TRL level and contribute to the start of rethinking the current processes in the economy. They can be regarded as essential performance goals enabling more quantitative and material related goals.

The connection of SRIA objectives to quantified targets found in the literature are given in Table 12 until Table 22. These tables give a selection of the literature in which quantification or concrete target setting was mentioned. Sometimes several and sometimes conflicting targets on the same topic were found. In this table we only show the quantifications/ targets that have been used for model input. A more technical explanation of how targets are modelled within the macro-economic model EXIOMOD can be found in Annex A.5.

In the following subsections the quantification of the subprogrammes are given for each Joint Programme.

2.1.1 Circular Cities

Table 12 and Table 13 give the quantification of the subprogrammes of 'Circular Cities'.

Table 12 Quantified targets for the Subprogrammes of Objective A of 'Circular Cities'

Objective A: to enable urban circularity and increasing citizen engagement in circular solutions	
	Literature used to quantify the subprogramme
Subprogramme A1: Infrastructure to enable circular material and product flows	(European Commission, 2018b) "Member States shall take the necessary measures designed to achieve the following targets: - by 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55 % by weight; - by 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60 % by weight; - by 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65 % by weight." (European Commission, 2019) "- In 2020 70% C&D waste "shall be prepared for re-use, recycled or undergo other material recovery" - In 2030 we put the same goal to 90% (some countries already had this in 2011, although that was including backfilling)"
Subprogramme A2: Citizen participation in circular material and product flows	(Rreuse, 2018) "According to recent estimates, 1/3 of all material arriving at recycling centers and civic amenity sites can still be re-used and at least 25% of electronic waste still has significant re-use value."
Subprogramme A3: Enhancing material efficiency and circular flows in the food and food packaging sector	(European Commission, 2018b) "- no later than 31 December 2025 the following minimum targets by weight for preparing for reuse and recycling will be met regarding the following specific materials contained in packaging waste: (i) 55 % of plastic; (ii) 60% of wood; (iii) 75% of ferrous metal; (iv) 75% of aluminium; (v) 75% % of glass; (vi) 75% of paper and cardboard - no later than 31 December 2030 a minimum of 75% by weight of all packaging waste will be prepared for reuse and recycled

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	- no later than 31 December 2030 the following minimum targets by weight for preparing for reuse and recycling will be met regarding the following specific materials contained in packaging waste: (i) 75% of wood; (ii) 85% of ferrous metal; (iii) 85% of aluminium; (iv) 85% of glass; (v) 85% of paper and cardboard." (Greenpeace, 2020) "Meat consumption in the European Union should drop by 71% by 2030, and by 81% by 2050, to tackle farming's contribution to climate breakdown, according to new analysis by Greenpeace. This would mean an average of no more than 460 grams of all types of meat leaving the slaughterhouse per person per week by 2030, and 300 grams in 2050, down from the current EU average of 1.58 kilograms per person per week." (Commission, 2020a) "The EU and the EU countries are committed to meeting the Sustainable Development Goal 12.3 target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains."

Table 13 Quantified targets for the Subprogrammes of Objective B of 'Circular Cities'.

Objective B: To Enhance circular economy and natural resource management in urban areas	
	Literature used to quantify the subprogramme
Subprogramme B1: Circular economy considerations of water and soil in food systems	(European Parliament , 2020) "We could potentially reuse 6.6 billion cubic metres of water by 2025, compared to the current 1.1 billion cubic metres per year. That would require an investment of less than EUR 700 million and would enable us to reuse more than half of the current volume of water coming from EU wastewater treatment plants theoretically available for irrigation, avoiding more than 5 % of direct extraction from water bodies and groundwater", she added." (European Environment Agency, 2018) "Agriculture accounts for the largest use of water: around 40 % of the total water used per year in Europe. Despite efficiency gains in the sector since the 1990s, agriculture will continue to be the largest consumer for years to come, adding to water stress in Europe. This is because more and more farmland needs to be irrigated, especially in southern European countries."
Subprogramme B2: Circular economy in land and soil resources in construction and urban planning	*No sources. No quantified link with an economic model.*
Subprogramme B3: Circular economy considerations in water supply and treatment systems	(European Parliament , 2020) "We could potentially reuse 6.6 billion cubic metres of water by 2025, compared to the current 1.1 billion cubic metres per year. That would require an investment of less than EUR 700 million and would enable us to reuse more than half of the current volume of water coming from EU wastewater treatment plants theoretically available for irrigation, avoiding more than 5 % of direct extraction from water bodies and groundwater", she added."
Subprogramme B4: Shifting towards circular water systems in buildings	(Kirhensteine, 2016) "A previous study conducted by BIO in 2012 concluded that EU policy on certification to promote rainwater harvesting and reuse in buildings could achieve a 5% reduction in potable water use by 2050 but would be applicable only for major renovation or new buildings." (European Environment Agency, 2018) "Mining and manufacturing accounts for 18 %, followed by household use, which accounts for around 12 %. On average, 144 litres of water per person per day is supplied to households in Europe.".

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2.1.2 Circular Industries

Table 14, Table 15, Table 16 and Table 17 give the quantification of the subprogrammes of 'Circular Industries'.

Table 14 Quantified targets for the Subprogrammes of Objective A of 'Circular Industries'

Objective A: To develop new technologies, processes, quality standards and analytic methods for new materials production and for resource and waste characterisation	
	Literature used to quantify the subprogramme
Subprogramme A1: Developing new technologies for new materials production	(European Commission, 2018c) *"Bio-based share of all chemical sales will rise to 22% by 2020; in the bio-based industries one million new jobs could be created by 2030, according to industry estimates"* (Biddy, 2016) "Recent analysis projects the market share of bio-based chemicals in the global chemical industry will increase from 2% in 2008 to 22% in 2025, and the market potential for bio-based chemicals will be $19.7 billion in 2016"
Subprogramme A2: Developing quality standards and analytic methods for materials production and characterization	*This subprogramme will contribute to other subprogrammes but does not have a standalone quantified target.*
Subprogramme A3: Developing new technologies for resource and waste characterization	(United Nations, 2015) "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" (Pardo, 2018) "The EU should follow the Dutch lead and work towards a 50% reduction in primary raw material consumption by 2050" (The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs , 2016) "The ambition of the Cabinet is to realise, together with a variety of stakeholders, an (interim) objective of a 50% reduction in the use of primary raw materials (minerals, fossil and metals) by 2030."

Table 15 Quantified targets for the Subprogrammes of Objective B of 'Circular Industries'

Objective B: To enable industrial symbiosis networks and foster digitalisation to master the complexity of products, processes and systems	
	Literature used to quantify the subprogramme
Subprogramme B1: Smart Factories - Building SME partnerships, "alliances of interests" and industrial symbiosis networks	(European Commission, 2019b) "Several of the following impacts are expected: • Improvement of at least 15% in energy efficiency of the targeted industrial processes, compared to the non-symbiotic scenario; • Reduction of at least 30% in total energy intensity, on the basis of full life cycle considerations; • Reduction in primary raw material intensity of up to 20%; • Reduction of waste generation by at least 25%"

Table 16 Quantified targets for the Subprogrammes of Objective C of 'Circular Industries'

Objective C: To raise awareness of industrial ecology by promoting new/better design and use of products and better re-use of materials already in circulation	
	Literature used to quantify the subprogramme
Subprogramme C.1: Promoting eco-design and eco-processes	(European Commission, 2020b) "As part of this legislative initiative, and, where appropriate, through complementary legislative proposals, the Commission will consider establishing sustainability principles and other appropriate ways to regulate the following aspects:

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	• improving product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products, and increasing their energy and resource efficiency; • increasing recycled content in products, while ensuring their performance and safety; • enabling remanufacturing and high-quality recycling; • restricting single-use and countering premature obsolescence; • introducing a ban on the destruction of unsold durable goods; • incentivising product-as-a-service or other models where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycle" (EIONET, 2019) "Waste furnishing: • An upstream prevention target by eco-design taking into account the end of life: 3 per cent of the quantity put on the market"
Subprogramme C2: Promoting re-use, repair and remanufacturing	(European Commission, 2018) "Member States shall take the necessary measures designed to achieve the following targets: - by 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55 % by weight; - by 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60 % by weight; - by 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65 % by weight." (European Commission , 2008) "Member States shall take the necessary measures to ensure that the following targets are attained by economic operators: (a) no later than 1 January 2006, for all end-of life vehicles, the reuse and recovery shall be increased to a minimum of 85 % by an average weight per vehicle and year. Within the same time limit the reuse and recycling shall be increased to a minimum of 80 % by an average weight per vehicle and year; For vehicles produced before 1 January 1980, Member States may lay down lower targets, but not lower than 75 % for reuse and recovery and not lower than 70 % for reuse and recycling. Member States making use of this subparagraph shall inform the Commission and the other Member States of the reasons therefor; (b) no later than 1 January 2015, for all end-of life vehicles, the reuse and recovery shall be increased to a minimum of 95 % by an average weight per vehicle and year. Within the same time limit, the re-use and recycling shall be increased to a minimum of 85 % by an average weight per vehicle and year."

Table 17 Quantified targets for the Subprogrammes of Objective D of 'Circular Industries'

Objective D: To reduce the carbon emissions of companies	
	Literature used to quantify the subprogramme
Subprogramme D1: Greenhouse gas accounting and management system (individual company*)	*This subprogramme will contribute to other subprogrammes but does not have a standalone quantified target.*
Subprogramme D2: Promoting secondary raw materials market and industry	(European Commission, 2018b) "(f) no later than 31 December 2025 a minimum of 65 % by weight of all packaging waste will be recycled; (g) no later than 31 December 2025 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: (i) 50 % of plastic; (ii) 25 % of wood; (iii) 70 % of ferrous metals; (iv) 50 % of aluminium; (v) 70 % of glass; (vi) 75 % of paper and cardboard; (h) no later than 31 December 2030 a minimum of 70 % by weight of all packaging waste will be recycled;

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	(i) no later than 31 December 2030 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: (i) 55 % of plastic; (ii) 30 % of wood; (iii) 80 % of ferrous metals; (iv) 60 % of aluminium; (v) 75 % of glass; (vi) 85 % of paper and cardboard." (European Commission Representation in Germany , 2019) "A minimum quota of 90 per cent for the separate collection of plastic bottles by 2029 (77 per cent by 2025) and the introduction of product design rules requiring the lids to be firmly attached to beverage bottles, as well as the target of 25 per cent recycled plastic in PET bottles from 2025 and 30 per cent in all plastic bottles from 2030."
Subprogramme D3: Reducing the carbon and GHG emissions in industrial systems	(European Commission, 2020c) "Key targets for 2030: • At least 32% share for renewable energy • At least 32.5% improvement in energy efficiency"

2.1.3 Closing the Loop

Table 18 to Table 20 give the quantification of the subprogrammes of 'Closing the loop'.

Table 18 Quantified targets for the Subprogrammes of Objective A of 'Closing the loop'

Objective A: To ensure that the manufacturing partnerships in Horizon Europe focus on key priorities in circular economy	
	Literature used to quantify the subprogramme
Subprogramme A1: Circular complex product design	(Pardo, 2018) "The EU should follow the Dutch lead and work towards a 50% reduction in primary raw material consumption by 2050" (Felipe, 2012) Figure 1 gives share of complex products per per product type (approximated numbers are taken).
Subprogramme A2: Circular business model strategies for complex products	(Circular Economy Action Plan , 2020) "In the light of these developments, and considering that illegal shipments of waste remain a source of concern, the Commission will take action with the aim to ensure that the **EU does not export** its waste challenges to third countries. Actions on product design, quality and safety of secondary materials and enhancing their markets will contribute to making "recycled in the EU" a benchmark for qualititative secondary materials." (Kleemann, 2018) "Thus, even a theoretical recycling of demolition waste at a rate of 100% and its sole utilization in the building sector could only substitute for about 35% of primary raw material demand." (Smedley, 2020) "Globally, the world produces as much as 50 million tonnes of e-waste a year – the equivalent to 6,000 Eiffel Towers – and it is growing 3-4% annually. It is estimated that to produce a year's worth of new equipment for Europe would require 2.9Mt of plastic, 270,000 tonnes of copper, 3,500 tonnes of cobalt and 26 tonnes of gold."

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Table 19 Quantified targets for the Subprogrammes of Objective B of 'Closing the loop'

Objective B: To address toxic / hazardous substances to human and environmental health in the context of circular economy	
	Literature used to quantify the subprogramme
Subprogramme B1: Circular design and technical development for human and environmental health	*This subprogramme cannot be modelled using Macro-economic model EXIOMOD.*

Table 20 Quantified targets for the Subprogrammes of Objective C of 'Closing the loop'

Objective C: To elaborate and stimulate the adoption of new policies, standard and protocols for governance resource management systems, fostering inter-stakeholder collaboration and integrated management in the entire value chain	
	Literature used to quantify the subprogramme
Subprogramme C1: Traceability and management of raw materials to support governance and standardisation	(European Commission, 2020d) "Budget for the EU on Research infrastructures (including e-infrastructure) (Ensuring access to world-class facilities) 2 488 million euro."
Subprogramme C2: Promoting market viable solutions for circular economy	*This subprogramme will contribute to other subprogrammes but does not have a standalone quantified target.*

2.1.4 Resource Efficiency on Territory and Sea

Table 21 and Table 22 give the quantification of the subprogrammes of 'Resource Efficiency on Territory and Sea'.

Table 21 Quantified targets for the Subprogrammes of Objective A of 'Resource Efficiency on Territory and Sea'

Objective A: Designing and promoting sustainable maritime transport	
	Literature used to quantify the subprogramme
Subprogramme A1: Transitioning to a circular and sustainable shipping industry	(Mofor, 2014) "The industry itself has set targets to reduce carbon dioxide emissions by 20% by 2020 and 50% by 2050. Ship operators, therefore, need to consider cleaner fuel and power options, including the use of renewables, to meet these targets. "

Table 22 Quantified targets for the Subprogrammes of Objective B of 'Resource Efficiency on Territory and Sea'

Objective B: Promoting efficient resource use in ports and coastal areas with a long-term perspective	
	Literature used to quantify the subprogramme
Subprogramme B1: Transitioning to integrated resource management approaches working at the territorial level with a holistic and circular perspective	*This subprogramme will not be modelled. Quantification could not be found and it is (partly) covered by the modelling of 'Circular Cities' and 'Circular Industries'.*
Subprogramme B2: Transitioning to a sustainable	(Pal, 2016)

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fishing and circular aquaculture sector	"In industry or local seafood shops, processing of seafood generates a huge quantity (50–80%) of nonedible by-products, which are discarded as waste or underutilised in several parts of the world." (European Commission, 2018d) "Reduction of waste disposal by 20% in the selected value chain, as compared to the current situation."

2.2 Qualitative description of scenarios

In the previous section the quantification of the subprogrammes for each Joint Programme is given. The subprogrammes are not modelled individually. Section 3 gives results for the four Joint Programmes and the combination of all joint programmes together.

Tables in this section can be used as handhold in the clarification of the results. They give a qualitative description of the measures that are implemented in the four different scenarios, i.e. joint programmes. For convenience we have clustered the implemented measures per joint program into topics.

Table 23 Qualitative description of the scenario 'Circular Cities'.

Topic	Qualitative description
Food	• Food waste shall be halved. Consequently, households will buy less food and food selling sectors will become more efficient; • Meat consumption will decrease and be replaced with a plant-based diet. • A higher share of food will be bought locally. So, more domestic food and less imported food. • The amount of plastic in food packaging will be reduced.
Waste	• More municipal waste will be recycled. The industries producing these products which are recycled will use the secondary material instead of raw material; • More Construction and Demolition waste will be recycled. The construction sector will use secondary material instead of raw material.
Water	• Households will consume less water; • Agriculture will use less water.

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Table 24 Qualitative description of the scenario 'Circular Industries'.

Topic	Qualitative description
Biobased chemicals	• The biobased share of all chemical sales increase to 22% in 2030. This share was equal to 3.04% in 2019.
Energy	• The share of renewable energy should be at least 32% • At least 32% improvement of energy efficiency in 2030.
Primary raw materials	• Reduction of industrial waste increases the supply of reprocessed raw materials. • All industries have a higher demand for reprocessed raw materials, and a lower demand for primary raw materials.
Reuse and leasing	• The industries that produce electronical devices and machinery will use 25% less raw materials in 2030. • Paper and paper products are used 30% less in 2030. • All industries have a lower demand for equipment, instead the demand for leasing product group increases.

Table 25 Qualitative description of the scenario 'Closing the loop'.

Topic	Qualitative description
Complex products	• Production processes of complex products have a lower demand for primary raw materials and a higher demand for reprocessed material inputs.
Export and import	• A ban of waste from the EU to regions outside the EU. • Inputs to the reprocessing industries should be from within the EU (e.g. waste). • Import of virgin materials from outside the EU are decreases. EU uses more domestic virgin materials.
Urban mining	• Urban mining of construction products and electronic products increase availability of reprocessed raw materials.
Investment in data system	• Governments of EU regions invest in development of data-systems to support circularity, such that industries are better able to manage supply chains. That is, industries see a slight reduction in production costs.

Table 26 Qualitative description of the scenario 'Resource Efficiency on Territory and Sea'.

Topic	Qualitative description
Sustainable marine transport	• The transportation sector over water (shipping) will start using more renewable fuels instead of fossil fuels.
Resource efficient fishing	• The fishing sector has a lot of waste, which will be valorised. As a result the sector becomes more efficient.

2.3 Macro-economic model EXIOMOD

This section gives a short description of the model used for this analysis. A more elaborate description is given by (Bulavskaya, 2016).

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EXIOMOD is an economic model able to measure the environmental and economic impacts of policies . As a multisector model, it accounts for the economic dependency between sectors. It is also a global and multi-country model with consistent bilateral trade flows between countries at the detailed commodity level. Based on national account data, it can provide compressive scenarios regarding the evolution of key economic variables such as GDP, value-added, turn-over, (intermediary and final) consumption, investment, employment, trade (exports and imports), public spending or taxes. Thanks to its environmental extensions, it makes the link between the economic activities of various agents (sectors, consumers) and the use of a large number of resources (energy, mineral, biomass, land, water) and negative externalities (greenhouse gases).

Compared to other existing multi-country economic models such as GTAP (Center for Global Trade Analysis - GTAP, 2014), ENV-Linkages (Chateau, 2014), GEM-E3 (Capros P. V., 2013a), E3ME (Cambridge Econometrics, 2014), GINFORS (Lutz, 2010) or NEMESIS (ERASME, n.d.), EXIOMOD 2.0 has several important features that allow customization of the model setup for each study:

- Based on a flexible modular structure, EXIOMOD can run (and compare) several standard economic modelling approaches. Where Input-Output (IO) analysis concentrates on the interdependence between economic sectors, general equilibrium analysis takes also into account price effects. Separating IO from general equilibrium effects simplifies the analysis of the results which overcome certain criticisms formulated to Computational General Equilibrium Models (CGEM) (see below).
- EXIOMOD can have the properties of the two main types of CGEM. Walrasian CGEMs (such GTAP, ENV-Linkages or GEM-E3) assume perfect prices flexibility whereas neo-Keynesian CGEMs (such E3ME, GINFORS or NEMESIS) assume market imperfections (e.g. involuntary unemployment) due to slow adjustment of prices and capital, labour and consumption. This difference may lead to major differences in the results.
- EXIOMOD uses the EXIOBASE database that covers a high level of detail on economic sectors (up to 200 products) as well as environmental extensions on emissions, resources, water and land use.

With these features, EXIOMOD is particularly well suited to evaluate the impact of policies related to climate change, energy and resource efficiency at the macroeconomic, sector and household levels:

- Environmental extensions allows for measuring the impact of economic activities on the use of a large variety of resources and other environmental indicators.
- The international trade flows allows for analysing the impact of national consumption pattern on the economy and on the resource use in other countries. This feature is particularly convenient to confront production based and consumption based indicators of resource footprint per country.
- The modular approach allows for separating direct and indirect effects, and in particular rebound effects.

2.3.1 *A modular approach*

EXIOMOD's name stands for EXtended Input-Output MODel. "Extended" refers to the fact that EXIOMOD can extend the standard Input-Output (IO) analysis in two main directions: (1) to Computational General Equilibrium Model (CGEM) analysis, and (2) to specific topics such as environmental impacts, energy, resources or transport. EXIOMOD is based on a modular approach specifically designed to conduct both IO analysis and CGEM simulation. With this modular approach and depending on the subject under investigation, the modeller can easily change the regional and sectorial segmentation as well as the level of complexity regarding the specification of the model by

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switching on or off specific blocks. This allows for customization, resulting in an appropriate model setup for each research question.

The main objective of this modular approach is to overcome several criticisms formulated to standard CGEMs. In particular, an important issue for the analyses of results obtained with a multi-sector and/or multi-region CGEM is the abundance of linkages and effects which are difficult to separate from one to another. This is all the more true since the results heavily depend on many assumptions such as the level of elasticity, closing rule, underlying data for the sector disaggregation. To some extent, CGEMs have become too complex to answer specific questions which are paradoxically embedded in them. Typically, whereas CGEMs use IO database, the complexity of their production and consumption structure makes it difficult to isolate IO from CGE effects.

On the contrary, EXIOMOD can distinguish different key effects embodied in CGEM which can greatly help the interpretation of the results. In particular, it can separate volume and price effects. The volume effects are directly derived from the IO analysis whereas price effects come from the general equilibrium framework. Within volume effects, EXIOMOD can isolate direct and indirect effects through the calculation of different type of multipliers (multipliers of intermediaries, of investments and of consumption).

2.3.2 Economic and environmental data

The current version of EXIOMOD uses the detailed Multi-regional Environmentally Extended Supply and Use (SU) / Input Output (IO) database EXIOBASE 3.0 (www.exiobase.eu). This database has been developed by harmonizing and increasing the sectorial disaggregation of national SU and IO tables for a large number of countries, estimating emissions and resource extractions by industry, harmonizing trade flows between countries per type of commodities. Moreover, it includes a physical (in addition to the monetary) representation for each material and resource use per sector and country.

The EXIOBASE database has one of the most detailed product and environmental extensions that are currently available from input-output tables. The database covers 49 regions (44 countries and five rest of the world regions), 200 product groups and various environmental indicators. For the project CICERONE, the economic database has been updated and rebalanced with recycling information from material flow analysis and data from Eurostat.

The environmental indicators are available as an extension to the input-output tables and are listed in the table below. Note that the 165 types of crops follow the FAO classification and are much more disaggregated than the crops in the input-output tables. The data for GHG emissions deviated a bit from the data on Eurostat. For CICERONE, the EXIOBASE database has been updated with data from Eurostat.

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Table 27 Environmental indicators covered in the EXIOBASE v3 database

Indicator	Level of detail	Examples
Emissions in kg	31 GHG and non GHG emissions	• CO_2 • CH_4 • N_2O • NH_3
Resource use in kg	165 types of crops	• Soybeans • Almonds • Cocoa beans
Resource use in kg Water use in Mm3	8 types of non-metallic minerals	• Slate • Gravel and sand • Salt
	9 types of fossil fuels	• Anthracite • Peat • Crude oil
	10 types of metals	• Iron • Copper • Lead

2.3.3 Conducting IO and CGEM analysis

EXIOMOD can perform a standard IO analysis which is typically useful to answer to the following type of questions. What is the economic impact of developing a particular sector (in terms of employment, value-added, investment, etc.)? Will domestic or foreign producers benefit the most? Which other economic sectors will benefit from it? With the inclusion of environmental extensions, IO tables can also be used to derive and compare various indicators of resource use: e.g. consumption-based versus production-based indicators. An example is the world map in terms of resource footprints shown in Figure 1 as published in the CREEA booklet.

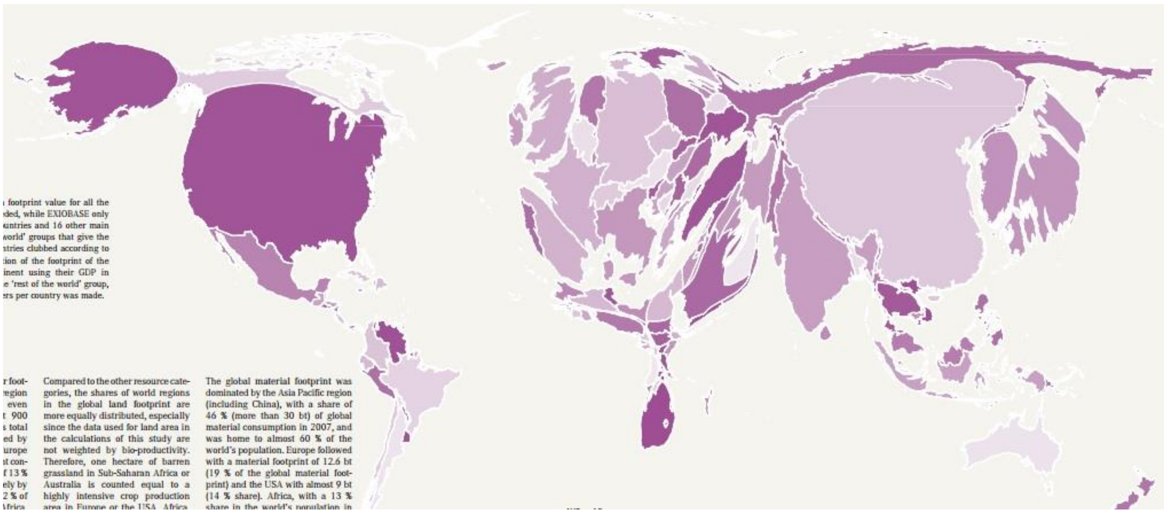

Figure 1: World map of resource footprints by country. Source: CREEA Booklet, see (Tukker, 2014)

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But IO analysis has the disadvantage to leave price effects aside. The CGE module can be activated to overcome this limit. EXIOMOD is then used as a CGEM. A CGEM takes into account the interaction and feedbacks between supply and demand as schematized in Figure 2. Demand (consumption, investment, exports) defines supply (domestic production and imports). Supply defines in return demand through the incomes generated by the production factors (labor, capital, energy, material, land, etc.). To ensure the equilibrium between supply and demand, an assumption regarding the "closure" of the system has to be done. Existing CGEMs generally choose between two main closures. The Walrasian closure assumes that perfect price flexibility ensures the instantaneous equilibrium between supply and demand. On the contrary, the Keynesian closure assumes that demand defines supply whereas price and quantities are rigid and adjust slowly to the optimum. Depending on the application, EXIOMOD can be run with different closures.

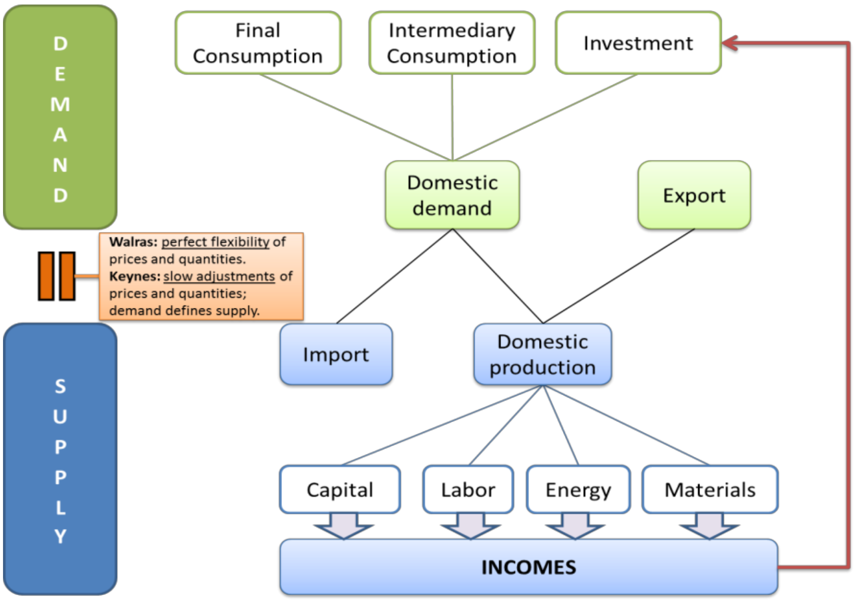

Figure 2: Architecture of a CGEM

2.3.4 Producers

The nesting structure used in the current version of the model is shown in Figure 3 but it can be easily adjusted using the modular approach of EXIOMOD. The production technology is modelled as a nested Constant Elasticity of Substitution (CES) functions. The nesting structure allows for introducing different substitution possibilities between different groups of inputs. At the first level, we assume that material inputs for production are perfectly complementary to the aggregate input of capital, labor, energy and that no substitution is possible between these inputs. At the second level, energy can be substituted to the aggregate input capital-labor. At the third level, the elasticity of substitution between labor and capital is equal to one and equals the Cobb-Douglas function.

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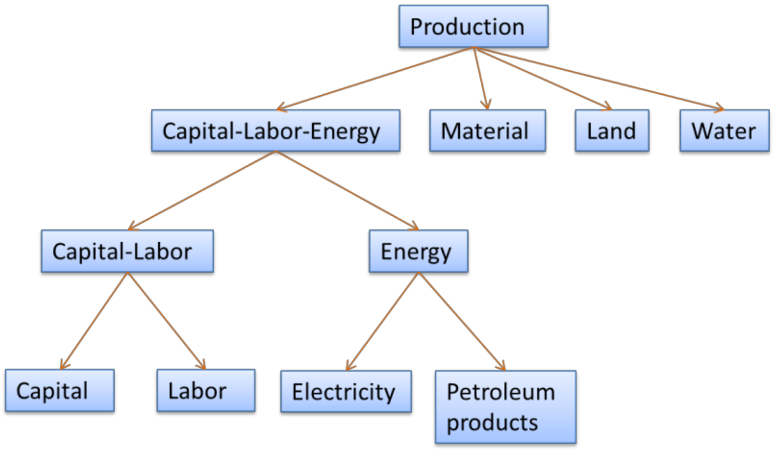

Figure 3: Production structure in EXIOMOD

2.3.5 Households

The household's utility is specified as a LES-CES function (Linear Expenditure System - Constant Elasticity of Substitution) allowing to differentiate between necessity and luxury products. This function defines a subsistence level for each good consumed which lead to an elasticity between consumption and revenue lower than one. For instance for food we have a high subsistence level, whereas for other products consumption is more sensitive to the level of income. For instance, the overall subsistence level of consumption corresponds to 33 percent of total consumption, but this level jumps to 80 percent for food products. Above this minimum level of consumption, substitution between goods is possible depending on the price. In the modular approach of EXIOMOD the household's utility function could be switched to the standard CES function in order to simplify the model.

2.3.6 Trade

The trade structure is schematized in Figure 4. At the first level, the user (e.g. final consumer or sectors) can either import a good or buy the good from the domestic market. In a second step, all imported products from the different users are aggregated to calculate the total level of imports. In a third level, imports can be supplied by different countries. We assume a CES function characterized by possibilities of substitutions between regions of origin. We assume that trade in energy, water and construction is much less flexible in terms of changing trade partners compared to trade of other products.

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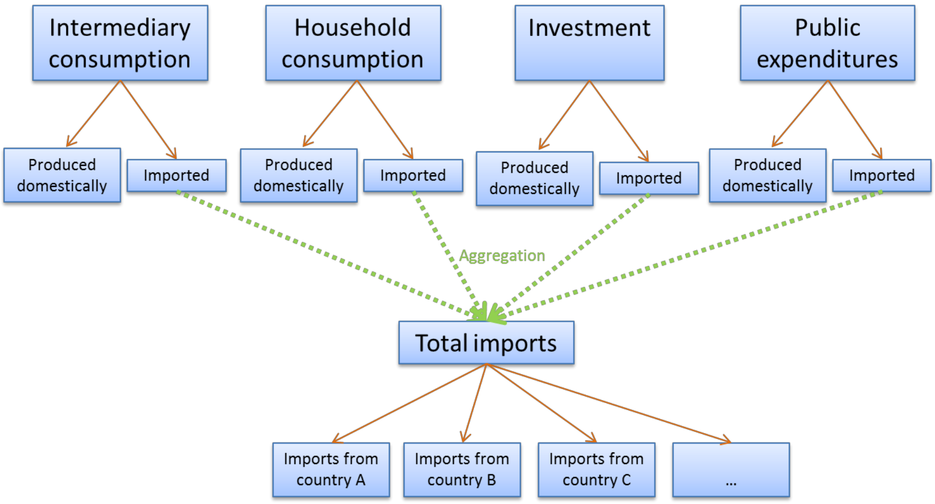

Figure 4: Trade structure in EXIOMOD

2.3.7 *Environment*

EXIOMOD related the resource use to the economic activity in several ways. CO_2 emissions are directly related to the level of consumption of the energy commodities responsible of the emission. Water consumption of economic activities is related to the level of production. For households, it is related to the water consumption (purchased from the water supply sector). Materials (such as metal, non-metallic minerals, etc.) are related to the production of the mining sector responsible of the extraction.

2.4 Macro-economic model EXIOMOD for CICERONE

EXIOBASE 3.0 is het database underlying to macro-economic model EXIOMOD. The database has 200 products, 163 industries, 43 countries and 5 Rest of World regions. However, for computational convenience, products, industries and regions are aggregated to the appropriate level for this project.

2.4.1 *Regions*

The EU is divided into four regions: North-EU, East-EU, South-EU and West-EU. The division of EU countries is based on Eurovoc[5].

- North-EU consists of the regions: Denmark, Estonia, Finland, Latvia, Lithuania, Sweden;
- East-EU consists of the regions: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia;
- West-EU consists of the regions: Austria, Belgium, France, Germany, Luxembourg and Netherlands, Ireland;
- South-EU consists of the regions: Cyprus, Greece, Italy, Malta, Portugal and Spain.

Figure 5 shows a map of Europe with the four EU regions.

Other regions outside the EU are defined as 'non-EU countries in Europe', 'Asia and Pacific', 'Americas', 'Africa and Middle East'.

[5] http://eurovoc.europa.eu/100277

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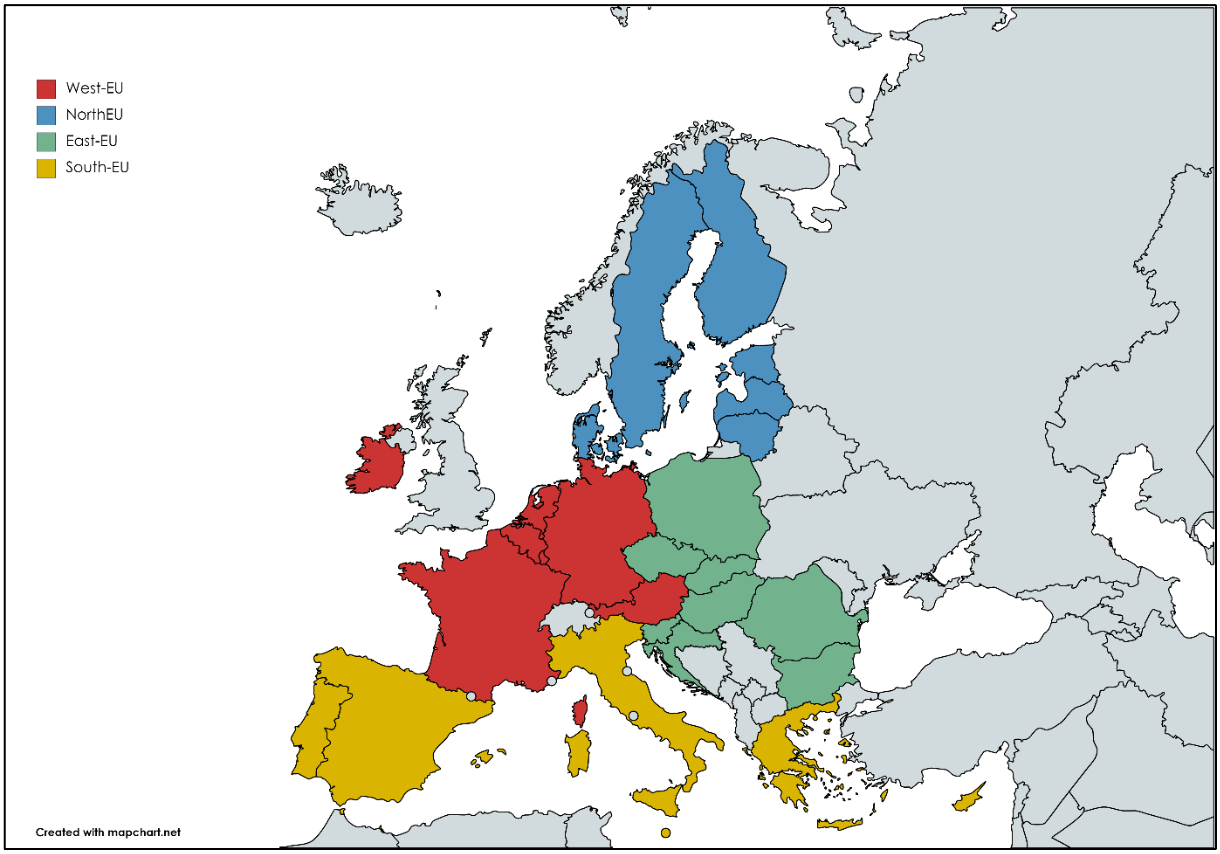

Figure 5: Map of Europe with the four EU regions

2.4.2 Product groups and industries

Table 28 shows an overview of the 36 aggregated industries used for quantification of the SRIA. The definition of product groups looks similar to the definition of industries, with iPLNT mostly producing the product group pPLNT. However, there are only 35 product groups. There is only one product group 'electricity', 'pELCT', that will to great extent be produced by the two electricity industries. The mapping of 200 product groups in EXIOBASE 3.0 to 35 products groups and 163 industries to 36 industries can be found in Annex A.3.

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Table 28 Overview of the industries used in CICERONE.

CICERONE industry code	Description
iPLNT	Crops and vegetable in agriculture sector
iANIM	Animal production
iFORE	Forestry and logging
iFISH	Fishing and aquaculture
iFOSM	Mining fossil fuels
iOTHM	Mining of metal ores and non-metallic minerals
iFBTO	Manufacturing of food, beverage and tobacco products
iTXWO	Manufacturing of textile, wood and printed products
iCOKE	Manufacturing of coke products
iREFN	Manufacturing of refined petroleum products
iCHEM	Manufacturing of chemicals and chemical products
iRUBP	Manufacturing of rubber and plastic products
iNMMP	Manufacturing of non-metallic mineral products
iMETP	Manufacturing of basic metals and metal products
iELEC	Manufacturing of electronic computer, optical and electrical equipment
iMACH	Manufacturing of machinery and equipment nec and other manufacturing
iELCF	Electricity fossil and nuclear
iELCG	Electricity green
iTRDI	Transmission and distribution services
iHWAT	Steam and hot water supply services
iWATR	Collected and purified water, distribution services of water
iCONS	Construction
iTRAD	Wholesale and retail trade
iHORE	Accomodation and food service activities
iTRAN_water	Transportation services water
iTRAN_other	Transportation services other
iREBA	Real estate, renting and business activities
iRENT	Renting of machinery and equipment without operator and of personal and household goods
iPUBO	Public administration, education, health and other activities
iWAST	Waste for treatment
iRECY	Recycling of waste and scrap
iREPR_TXWO	Re-processing of secondary textile, wood and printed products
iREPR_RUBP	Re-processing of secondary rubber and plastic products
iREPR_NMMP	Re-processing of secondary non-metallic mineral products
iREPR_METP	Re-processing of secondary basic metals and metal products
iREPR_CONS	Re-processing of secondary construction material

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3. Results

This section presents the impact of four joint programmes on economy and environment. The results of the four joint programmes are compared with the baseline. The baseline presents the business as usual situation, where no circular targets are included. In a scenario analysis, where each scenario refers to one of the joint programmes, the impact of the SRIA is assessed up to 2030. This is also the year for which most targets are defined by the European Commission and other reports (see Table 12 – Table 22).

Section 3.1 presents the results for the baseline. This section also gives some extra explanation on the different output indicators. Section 3.2 presents the results for the four Joint Programmes in comparison to the baseline. Results of the combined scenario with all joint programmes are also presented in this section. Conclusions and recommendations can be found in the next section.

3.1 Baseline

The baseline describes the business as usual situation. Besides historic trends for the years 2011-2019, no circularity measures are included in this scenario. It does include a trajectory for growth in population and Gross Domestic Product (GDP). The trajectories for GDP and population for EU countries are taken from the EU Reference scenario (Capros P. D., 2013b), based on runs from the PRIMES model. Forecasts for GDP and population non-EU countries are taken from the (OECD, 2020)[6]. For the years 2011-2019, historical data for all regions have been taken from the World bank.[7]

In addition, the business-as-usual scenario includes slight improved trend in CO2 efficiency and material efficiency for the four EU-regions.

3.1.1 GDP

GDP trajectories are taken from exogenous sources (EU reference scenario). This implies a 20% increase for North-EU (NEU), 15% for South-EU (SEU), 12% for West-EU (WEU), and 23% for East-EU (EEU) between year 2020 and 2030. Figure 6 gives the trajectory for GDP for the four EU regions.

[6] https://stats.oecd.org/Index.aspx?DataSetCode=POPPROJ
[7] https://databank.worldbank.org/source/world-development-indicators

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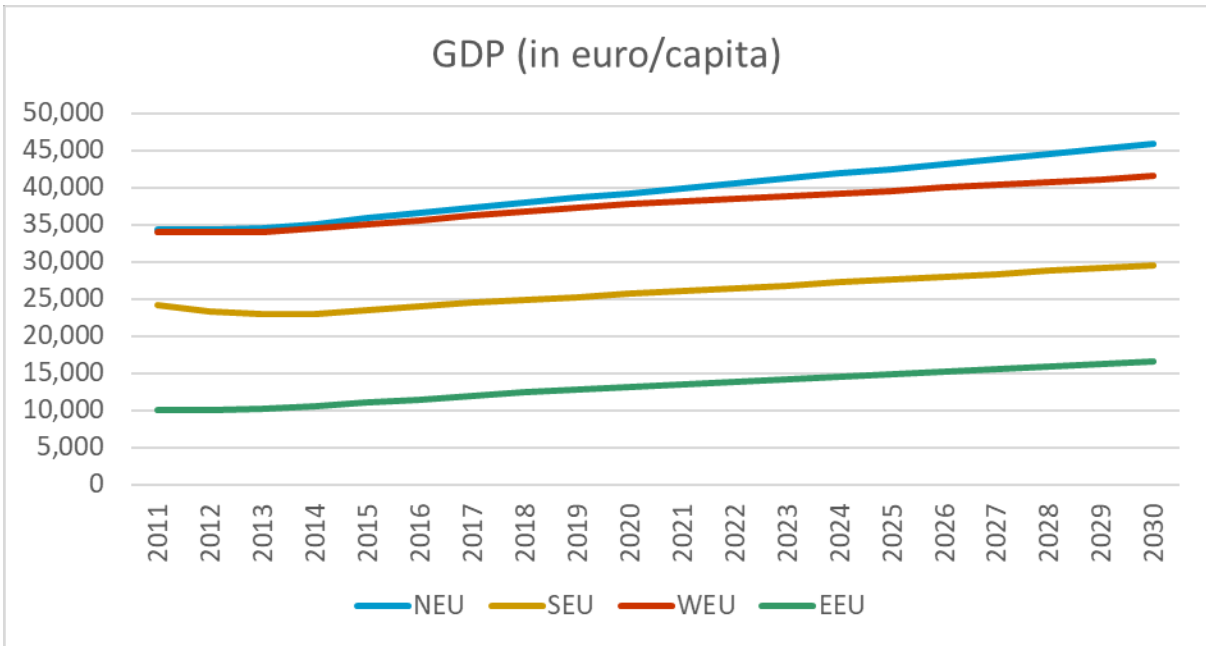

Figure 6: GDP in million euro for the four EU regions for the baseline scenario

Since EU regions differ in size, we also present GDP development per capita in Figure 7, giving insight in the relative welfare position of each of the regions.

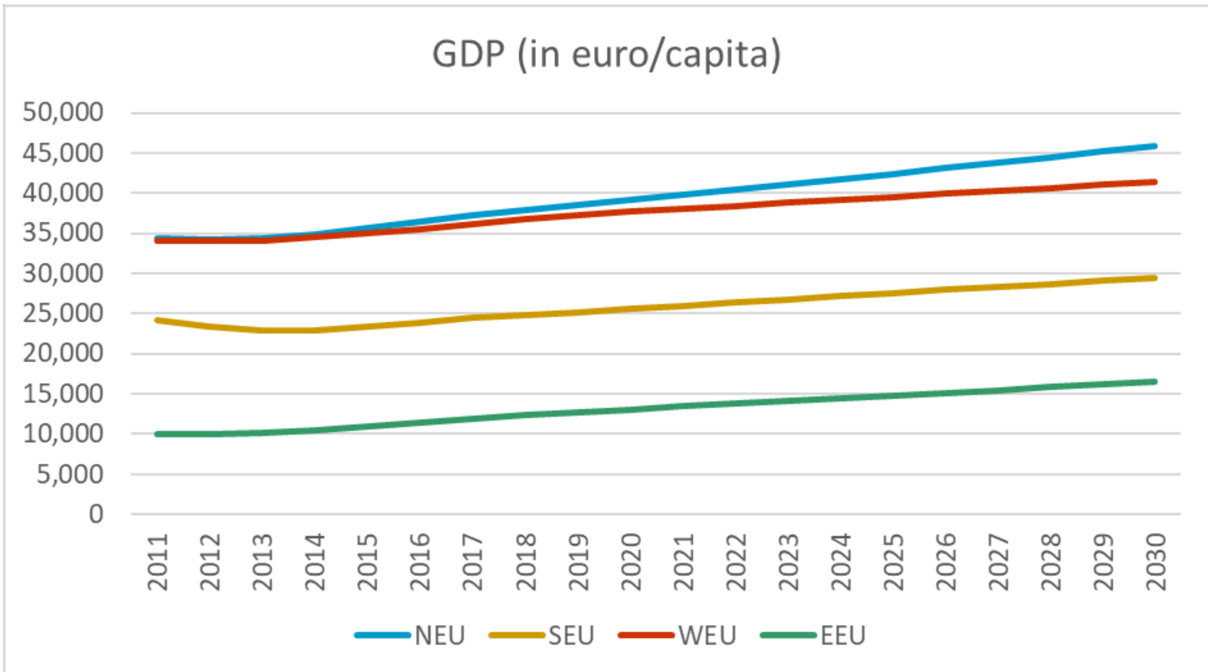

Figure 7: GDP per capita in euro per capita for four EU regions for the baseline scenario

3.1.2 Employment

Total employment per region is endogenously determined by the model. Figure 8 shows that employment increases for all European regions. That is, 6% more manhours are needed between

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2020 and 2030 for North-EU, 4% increase for South-EU, 4% for West-EU, and 6% for East-EU. This increase can to a great extend be explained by the increasing value of the economy (GDP increase).

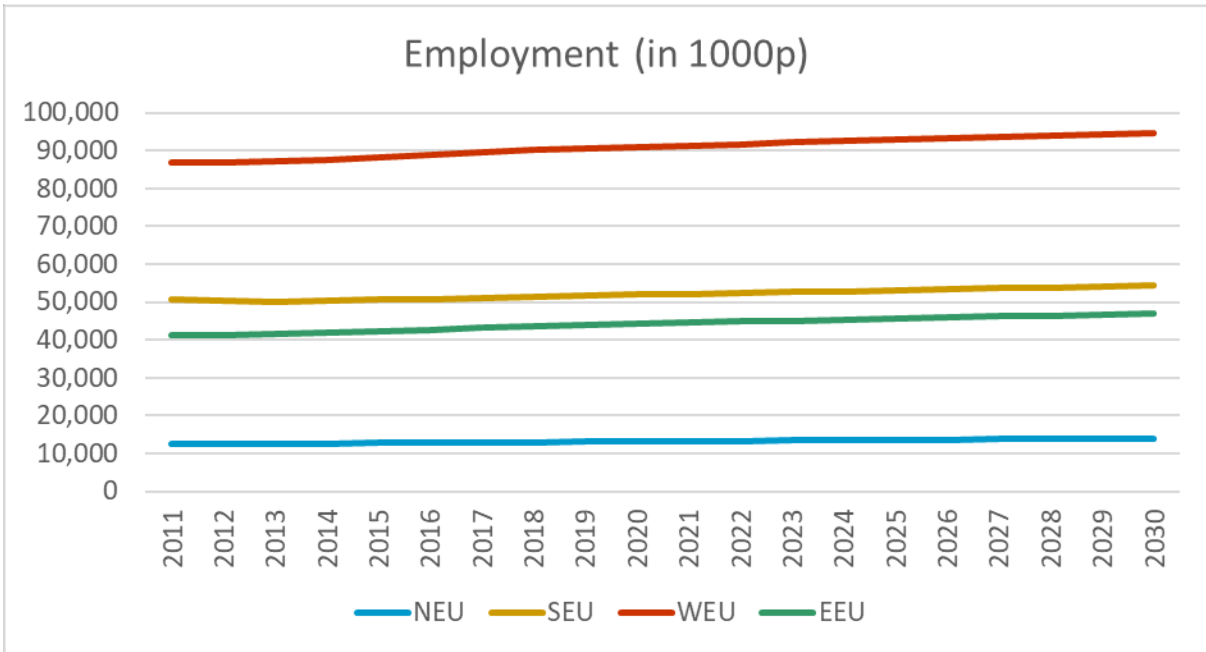

Figure 8: Employment in 1000 persons for four EU regions for the baseline scenario

Figure 9 shows for the business-as-usual situation the employment share of total population. The employment shares increase with 4% between 2020 and 2030 for North-EU, 4% for South-EU, 2% for West-EU and 9% for East-EU. Thus, it is expected in the business-as-usual situation that each EU region will have a larger share of the population employed by 2030.

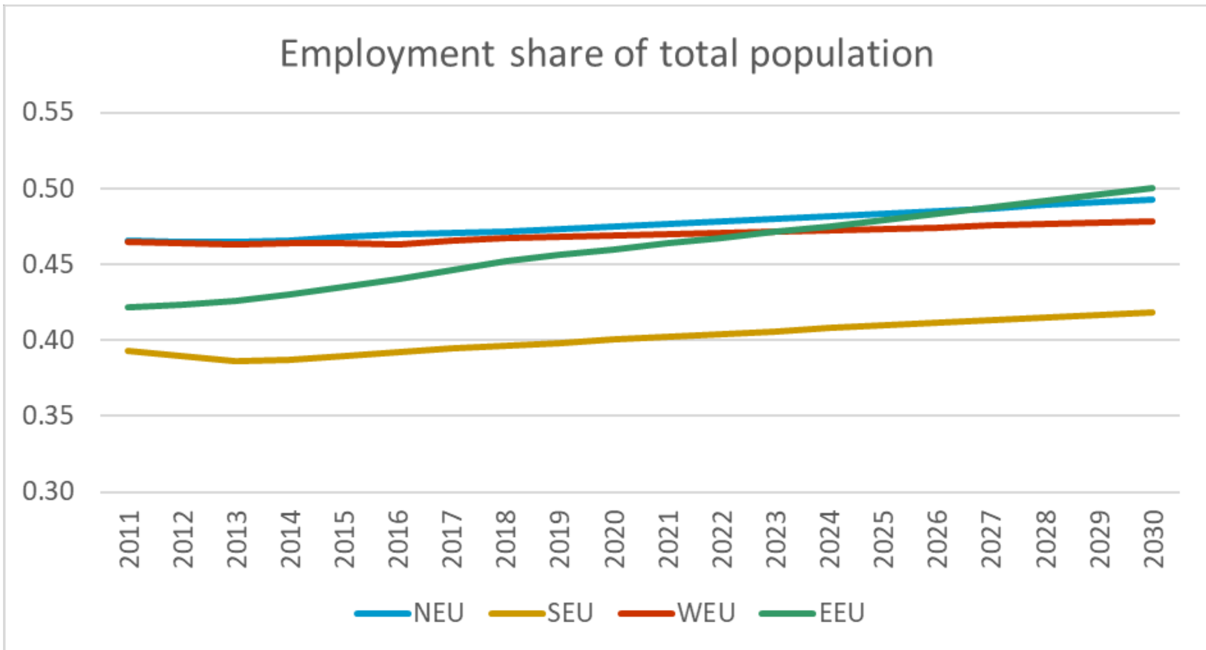

Figure 9: Employment share of the population for four EU regions for the baseline scenario

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3.1.3 Greenhouse gas emissions

Greenhouse gas (GHG) emissions include CO_2, CH_4 and N_2O emissions. In the literature two definitions of emissions are reported, i.e. consumption based and production based emissions. We will report both definitions in this report. Below the two definitions are explained. In addition, Box 1 gives an illustrative example to support this explanation.

Emissions are in general measured in terms of ‘production’. It is the total amount of emissions emitted within the territory of a region. Climate agreements in general set targets on the production based emissions. However, this type of emissions does not take into account that developed countries purchase more goods (and are therefore responsible for more emissions that were emitted outside their own region). Therefore we also report the consumption based emissions, which is also often referred to as the CO_2-‘footprint’ of a region. Consumption based emissions reflect all emissions that a region is responsible for due to its final consumption (of e.g. households and governments). This definition includes all emissions emitted during the full value chain of goods purchased in that region. These emissions are corrected for trade.

Then, there is a third emissions term that deserves some explanation, the final demand emissions. These emissions are emitted during the final consumption of goods by households or governments and not during the production process. Examples are heating of houses, cars driven by consumers (thus, not taxis and busses). These type of emissions are part of both consumption and production based emissions. Note that this third type of emissions is not included in the analysis for this report.

The following relation should always hold: total production based emissions worldwide equals total consumption based emissions worldwide. The only difference between the two definitions is who is held ‘responsible’ for the emissions.

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Box 1: Production and consumption based emissions

We explain the difference between production and consumption based emissions using the example of one car. This car consists of four parts: tires, an engine, the body work, and suspension. In this example, tires and engine are produced in West-EU, body work in South-EU and suspension in East-EU. Resources and other work (e.g. assembly of the car) comes from the Rest-of-World region (RoW). The figure below illustrates the location where production of all parts takes place and related emissions. In the end, the car is bought by a consumer in North-EU.
The table shows production and consumption based emissions for each region. Production based emissions in West-EU are equal to 4 ton CO_2-eq. That is, the production of engine and tires result in 3 and 1 ton CO_2-eq respectively. However, consumption based emissions in West-EU are equal to zero, because the car is not bought in this region. Similarly, South-EU, East-EU and RoW-region have positive production based emissions, but no consumption based emissions. On the other hand, North-EU has no production based emissions, but consumption based emissions of 12 ton CO_2-eq. Its production based emissions are zero, because production takes place outside this region. Consumption based emissions are all dedicated to North-EU, because it is the region in which the car is finally bought.
This is the example of just one car. When the example is extended to the total car industry, each region will have production and consumption based emissions. However, there will be a difference between regions that mainly consume cars and regions that mainly produce cars.

Regions	**Production based emissions (ton CO_2-eq)**	**Consumption based emissions (ton CO_2-eq)**
North-EU	0	12
South-EU	4	0
West-EU	4	0
East-EU	2	0
RoW	2	0

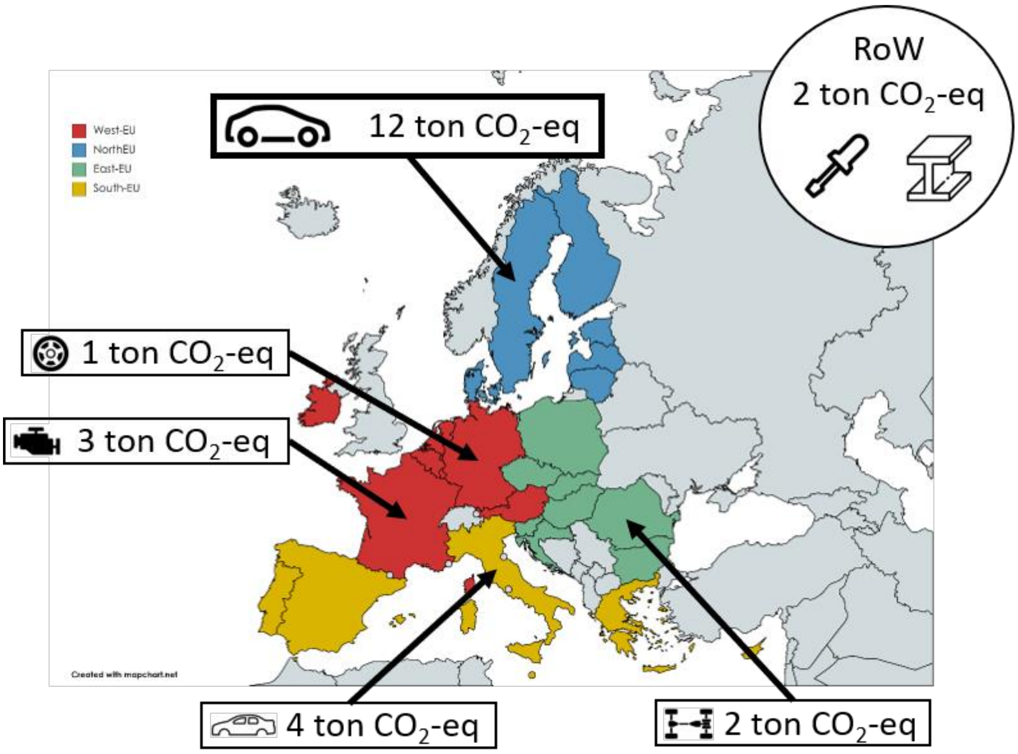

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Figure 10 shows production based emissions per capita for all four EU regions. The baseline assumes a decreasing trend in carbon emissions, an assumption based on the EU reference scenario (Capros P. D., 2013b). Figure 6 shows an increasing GDP in all EU regions. A growing economy in implies an increase in economic activities, which very likely cause an increase in emissions. Despite the increasing growing economy, there is still a decrease in GHG emissions per capita between 2020 and 2030. For North-EU regions that is equal to 7%, 7% for South-EU, 12% for West-EU and a slight increase (1%) for East-EU. East European countries also had the steepest growth in economy. Figure 11 shows consumption based emissions, that is, emissions for which the EU is responsible for via final consumption of EU citizens.

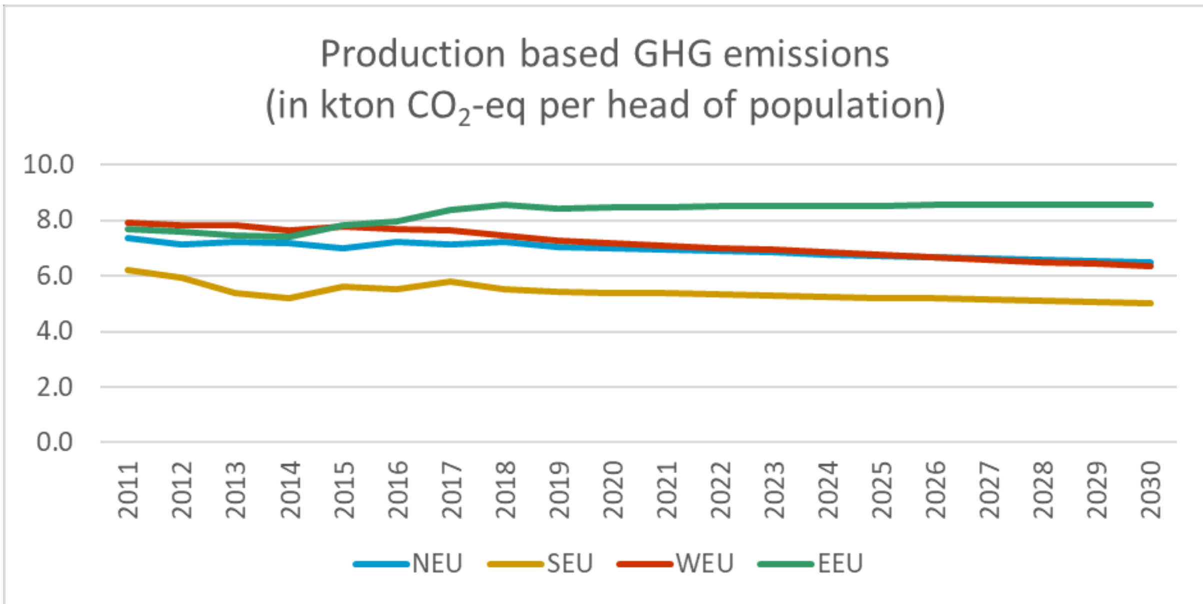

Figure 10: Production based Greenhouse Gas emissions in kilotonnes CO_2 equivalents per head of population for the baseline scenario. This includes CO_2, CH_4 and N_2O.

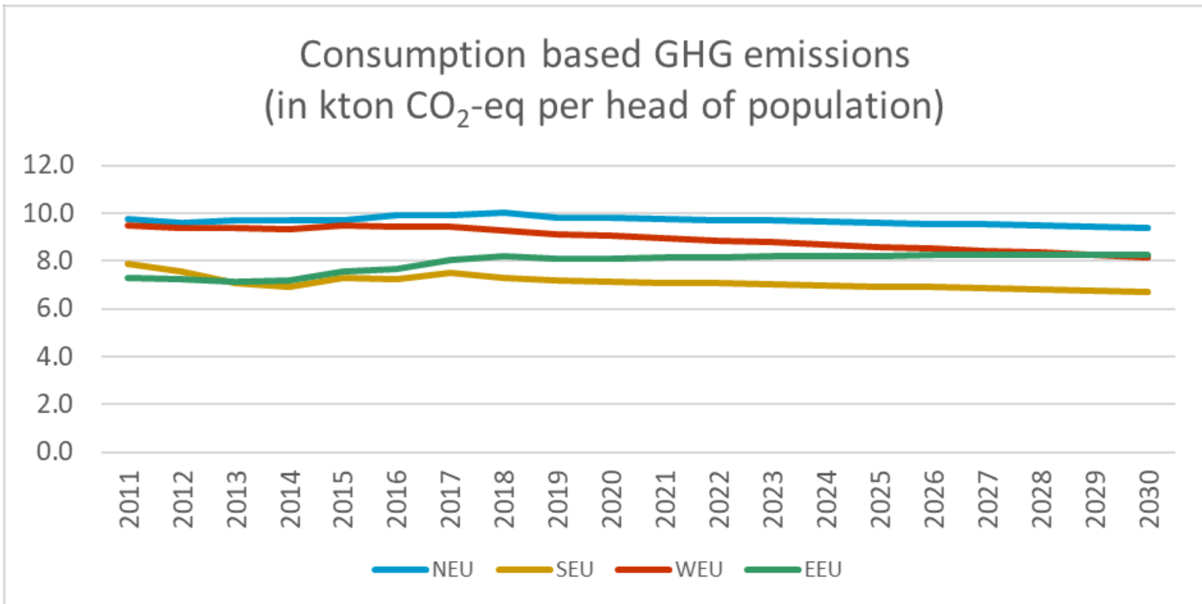

Figure 11: Consumption based Greenhouse Gas emissions in kilotonnes CO_2-equivalents per head of population for the baseline scenario. This includes CO_2, CH_4, N_2O.

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3.1.4 Raw material use

First, let us clarify our definition of ‘raw material use’. EXIOBASE, the database underlying to the macro-economic model, gives data of Domestic Extraction Used (DEU) per region, industry and material type. The OECD definition defines DEU as “*the flows of raw materials extracted or harvested from the environment and that physically enter the economic system for further processing or direct consumption (they are used by the economy as material factor inputs).*” EXIOBASE shows for example that most metals are harvested in the mining sectors and biomass in the agricultural sectors. The EXIOBASE data has been calibrated to totals of Domestic Extraction Used from Eurostat per region and material type.

Our definition of materials include the following categories: biomass, wood, fossil fuels, metal ores and non-metallic minerals. For a more detailed specification of these categories, we refer to Annex A.2.

The baseline includes an assumption for a slightly net decreasing trend in materials (based on data from Eurostat between 2011-2019 and forecasts for 2019-2030 from (Wang, 2014)), although at the same time GDP is still increasing, leading to an upward effect on the use of most materials.

Material consumption can also be shown from a production and a consumption based point of view. Figure 12 shows material extracted per head of population for the production based definition, which is in fact the same as Domestic Extraction Used (DEU). Figure 13 shows materials use per head of population for the consumption based definition. Consumption based material use also takes *upstream* flows related to import and export of raw materials and products into account (note that this is not the same as Domestic Material Consumption). More specifically, consumption based material use is total material extracted for all product groups purchased by final users in a region.

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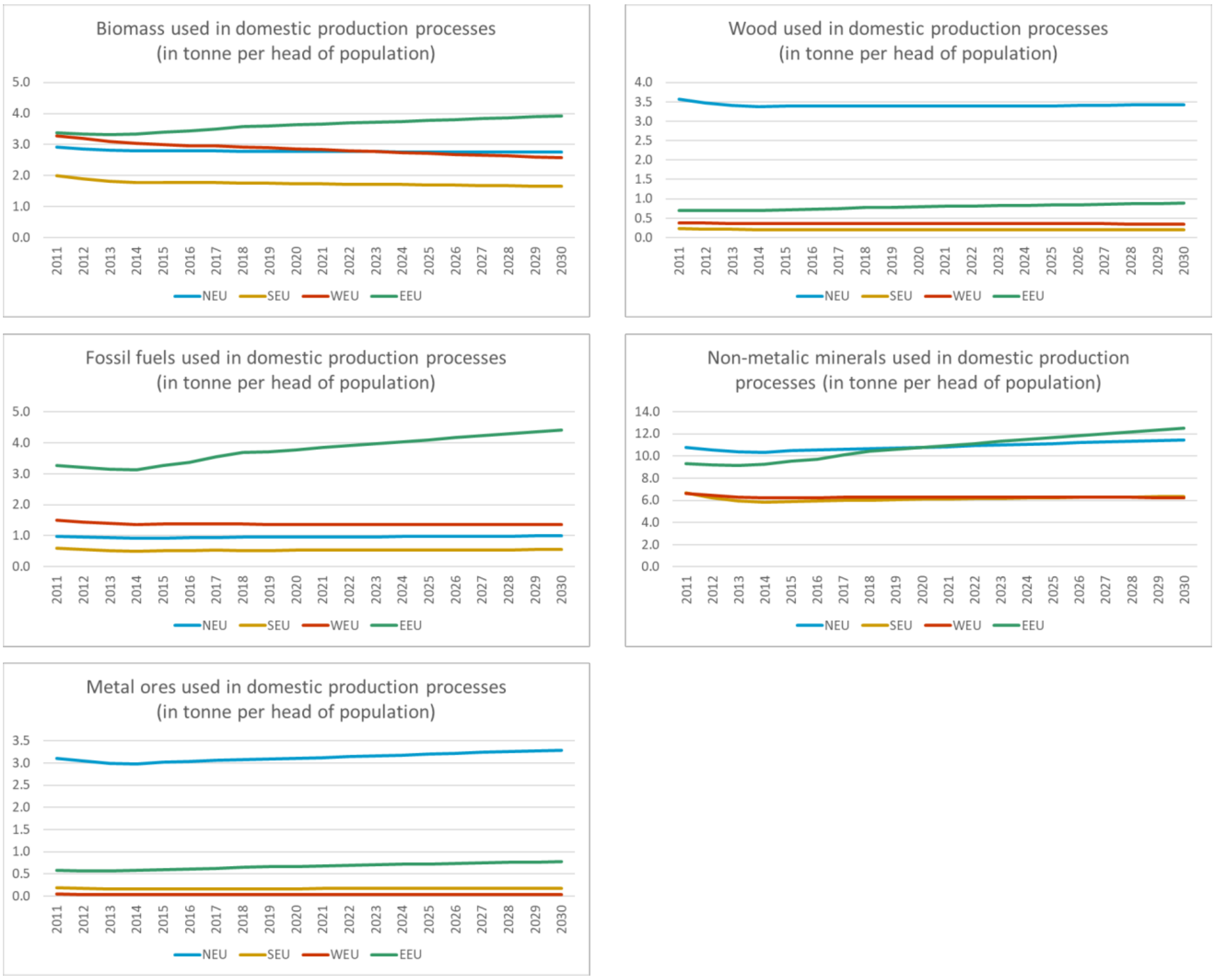

Figure 12: Use of materials in domestic production processes in tonnes per head of population for 2011-2030 for the baseline scenario

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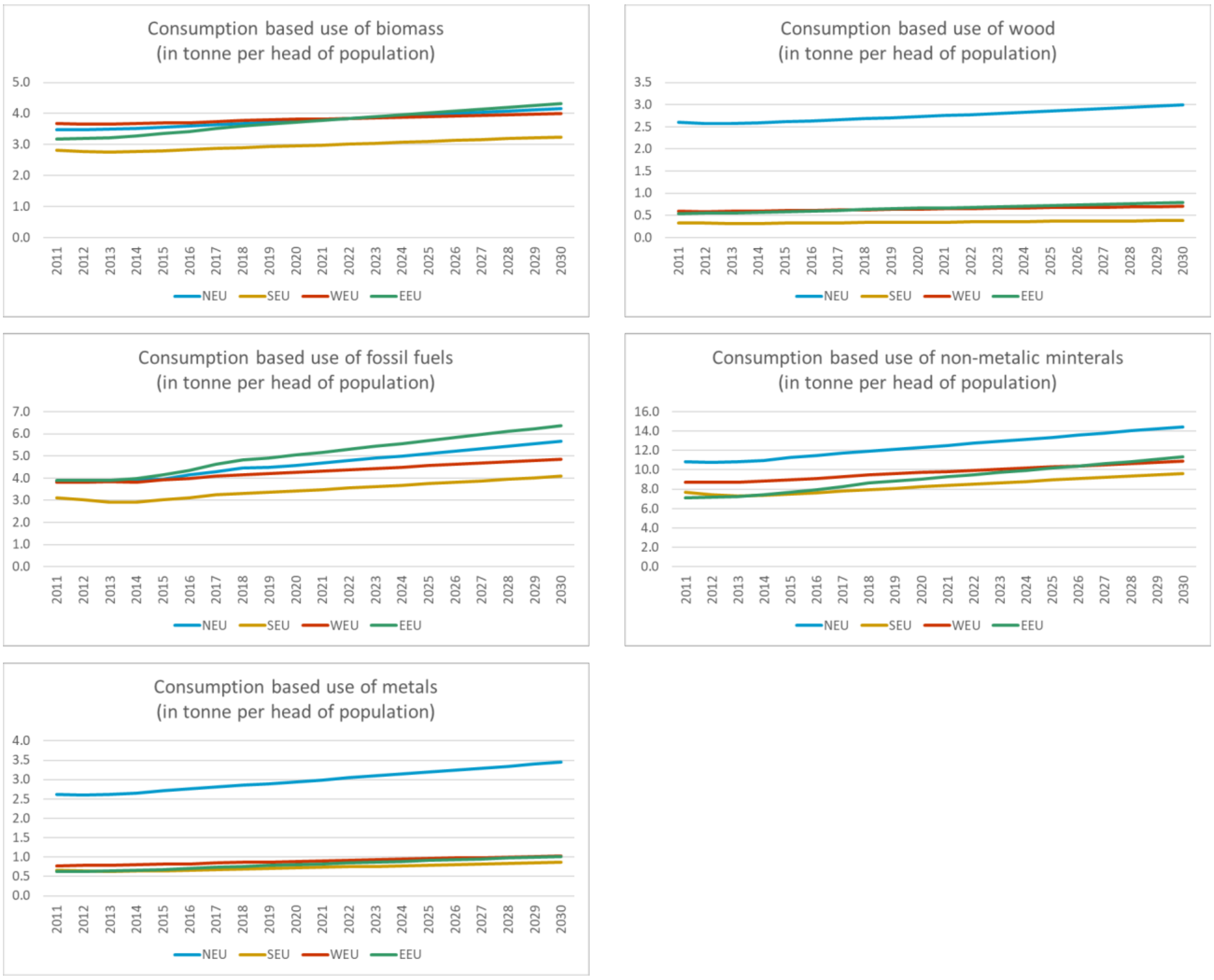

Figure 13: Consumption based material use in tonnes per head of population for 2011-2030 for the baseline scenario

3.1.5 Secondary material use

Let us first explain our meaning of ‘Secondary material use’, by explaining how the data was constructed. This data was originally not part of database EXIOBASE. It was constructed from four data sources: (1) Total material use in production processes per country and material type from Eurostat[8]. (2) circular material use rate per country from Eurostat[9] (3) circular material use rate per material type from Eurostat[10] (4) industry shares for DEU material types from EXIOBASE 3.0. Annex A.4 gives a table for secondary materials that resulted from combining information from the first three data sources.

Eurostat gives circular material use rates for four material types: biomass, metal ores, non-metallic minerals and fossil energy materials/ carriers. Therefore, we add data to the database for these four secondary material types. For connecting the secondary materials to the industries, we make two separate assumptions. For secondary non-metallic minerals it is assumed that all are produced in the reprocessed non-metallic mineral industry (iREPR_NMMP), and all secondary metals are produced in

[8] See table ‘ENV_AC_SD’ from Eurostat (https://ec.europa.eu/eurostat)
[9] See table ‘env_ac_cur’ from Eurostat (https://ec.europa.eu/eurostat)
[10] See table ‘env_ac_curm’ from Eurostat (https://ec.europa.eu/eurostat)

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the reprocessed metal industry (iREPR_METP). For secondary biomass and secondary fossil energy materials/ carriers we use the industry shares for Domestic Extraction Used for Biomass and Fossil Fuels respectively from EXIOBASE. Therefore, similar to our definition for raw material use, secondary material use refers to 'extracted' or 'produced' materials within the EU.

The baseline includes an assumption for a slightly decreasing trend in materials extracted, based on data from Eurostat between 2011-2019 and forecasts for 2019-2030 from (Wang, 2014) (See Figure 14). This decreasing trend also holds for secondary materials. Again, as was the case with primary materials, the increasing GDP results in an underlying trend of increased 'extraction' of most secondary materials. Note that the baseline is a business as usual situation and therefore does not yet include circular economy assumptions, which explains the increasing use of all materials, and thereby also secondary materials.

For secondary materials only the production based definition is shown in Figure 14. We do not show secondary materials use for the consumption based emission (That is, all secondary material use that EU households are responsible for further along in the value chain. This would also include secondary materials extracted in regions outside Europe for final consumption of a product group in the EU.). This decision is motivated by the lack of data on (physical) secondary materials per region, material type and industry for regions outside Europe. As explained, data for secondary materials within the EU have been collected for this project.

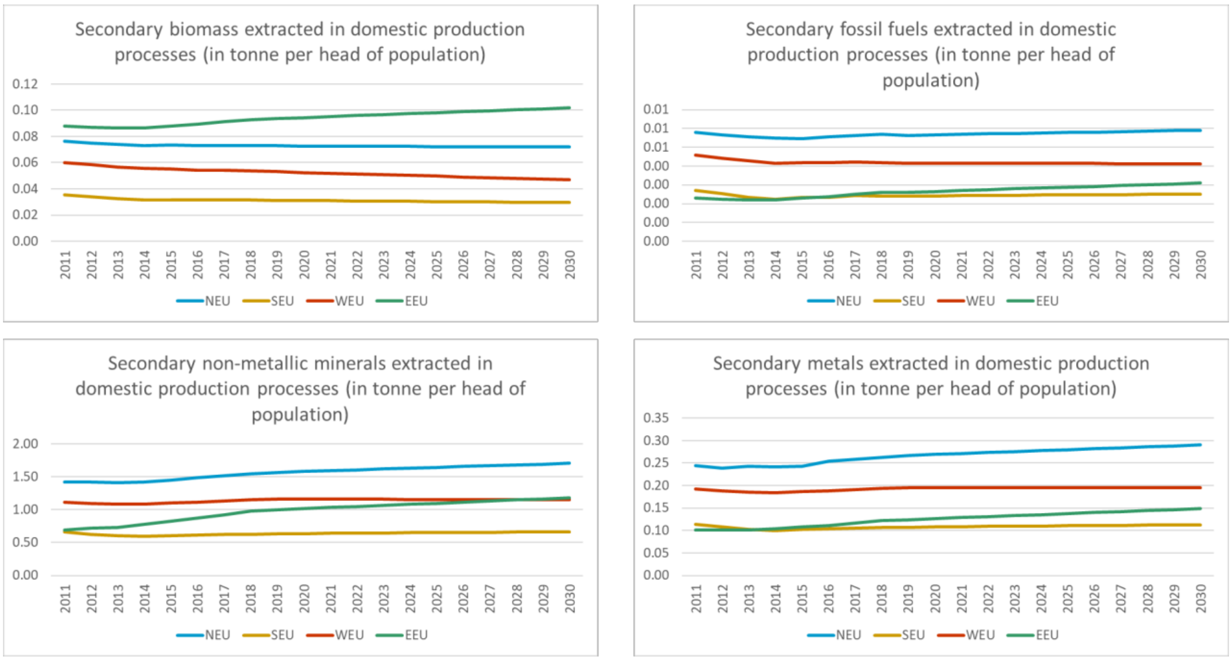

Figure 14: Consumption based secondary material use in tonnes per head of population for 2011-2030.

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3.1.6 Extracted resource productivity

Out definition of Extracted resource productivity is equal to Gross Domestic Product (GDP) divided by Domestic Extraction Used (DEU)[11]:

$$ERP = \frac{GDP}{DEU},$$

with GDP in million euros, and DEU in kilotons, which makes the unit of resource productivity euro/kilogram.

Trajectories for DEU are illustrated for the baseline in Figure 12. Also, only raw material use is included in the calculation, not secondary material use.

Extracted resource productivity is illustrated in Figure 15. We find an increasing pattern, because GDP is increasing faster than the increasing material use over years. Material use is decreasing for all EU regions except for East-EU. However the economy is still growing faster compared to the use of materials. Therefore, also for East-EU extracted resource productivity shows an increasing trajectory for the baseline. The increase of ERP between 2020 and 2030 for North-EU countries is equal to 12%, 13% for South-EU, 14% for West-EU, and 10% for East-EU.

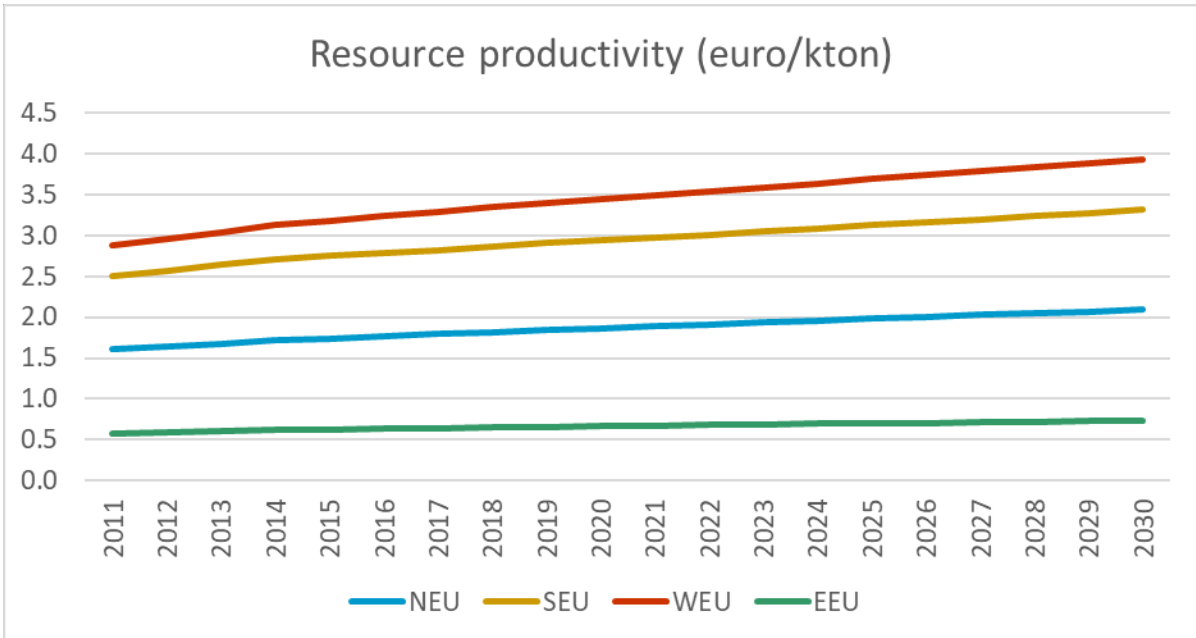

Figure 15: Extracted resource productivity in euro / kton for 2011-2030

[11] This definition has been inspired by the definition of Resource Productivity (RP), which is equal to GDP divided by Domestic Material Consumption (DMC). Due to lack of data on DMC on industry, region and material level, Extracted Resource Productivity is presented in this report.

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3.1.7 Relative Competitiveness Index

A relative competitiveness indicator is developed to highlight the impact of the policy scenarios on the competitive position of a region. It answers the question: are the product prices in a certain region competitive with the product prices of imported products from foreign competitors?

When the competitiveness indicator is smaller than one, the price of (foreign) competitors is higher than the basic domestic price. This is the case for all developing regions. For competitiveness indicator higher than one, the prices of other regions in the world become relatively smaller over the years. This implies a worsened competitive position. Which will be the case for developed regions like the four EU-regions. The exact formulation behind the relative competitiveness indicator is given in Annex A.1.

Since the base year of EXIOMOD is 2011, relative competitive index in this year is one for all regions. Due to GDP and population changes for future years, relative competitiveness relations between the regions start to change.

Figure 16 shows the relative competitiveness indicator for all regions in the world, because it is important to illustrate which regions 'win' and which regions 'lose'. The non-EU regions are illustrated with dotted lines. The relative competitiveness indicator for most EU regions increases, meaning that their competitive position worsens.

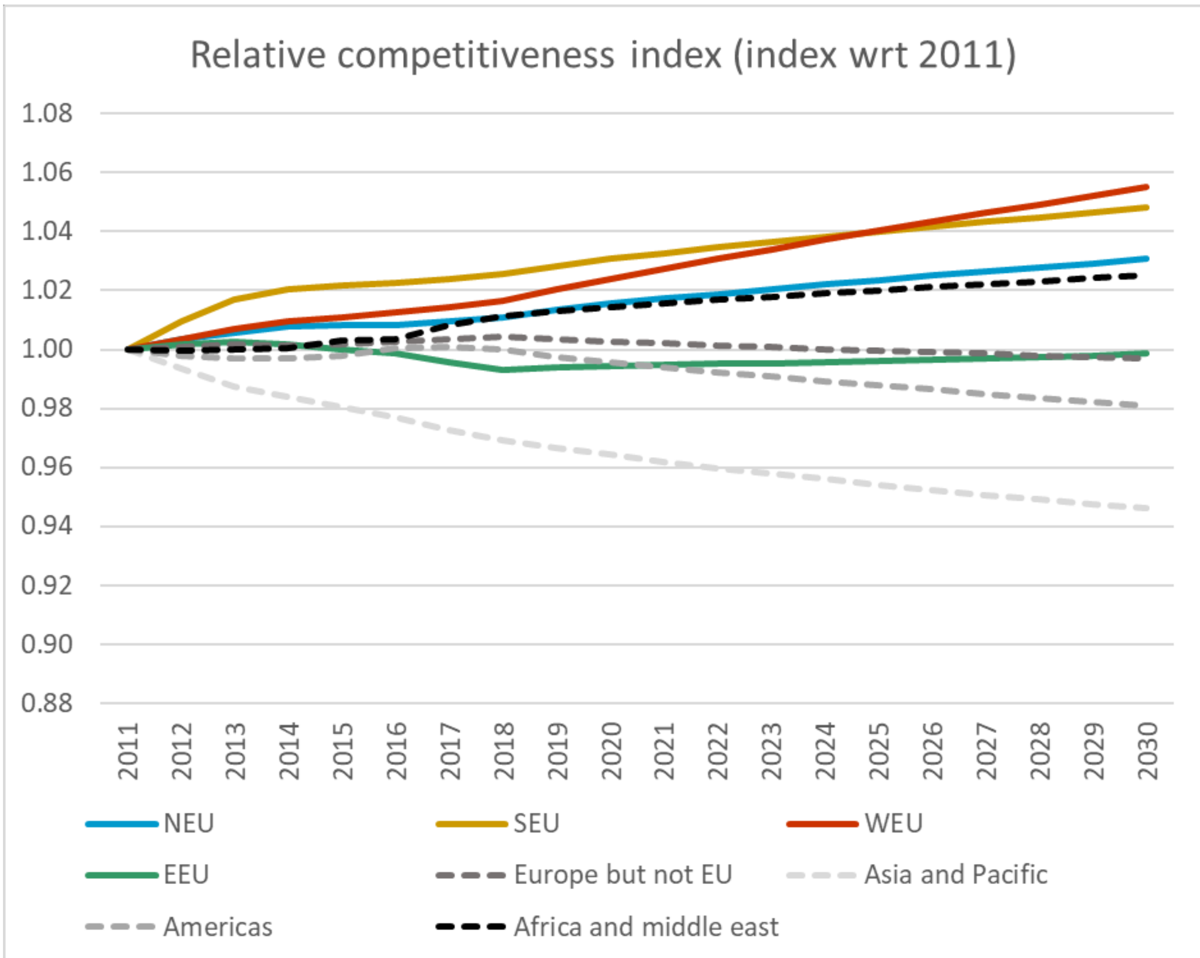

Figure 16: Relative competitiveness for 2011-2030 for all regions in the world.

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3.1.8 Other output parameters

Most important indicators are presented and discussed in this section. More detail on the industry or product group level of these indicators can be found in Annex B. This Annex also presents information on additional indicators. That is, output in million euro per region and industry, price indices per region and product group, household expenditures per region and product group.

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3.2 Scenario analysis

This section describes the effect of five scenarios on GDP, employment, emissions, material consumption, Extracted Resource Productivity, relative competitiveness index, output per sector, prices, trade and household expenditures. The five scenarios for which the economic and environmental impact has been calculated are the four joint programmes and a combined scenario in which targets set in scenario 1-4 are taken together in one scenario:

- Scenario 1: Circular Cities
- Scenario 2: Circular Industries
- Scenario 3: Closing the Loop
- Scenario 4: Territory and Sea
- Scenario 5: Combined scenario SRIA.

Note that due to rebound effects and stacking of measures, the results of the four joint programme scenarios together do not exactly add up to the combined scenario. With 'stacking of measures' we refer to measures that are more or less overlapping in different joint programmes. Double-counting of measures is prevented in modelling the combined scenario.

As was the case for the baseline, for all scenarios we show the trajectories from base year 2011 until 2030. The results again focus on the four EU regions, unless the trade relation with non-EU regions adds insight into the results. The results shown in this section are given on a somewhat aggregated level. More detail (e.g. product and sector disaggregation) on the results can be found in Annex A.3.

A qualitative description of the measures behind each of the scenarios was presented in section 2.2. It is convenient to use this list as handhold in the clarification of the results for each Joint Program. We assume that only Europe implements these circular economy measures, where all other regions (Asia and pacific, Americas, non-EU regions in Europe, Africa and Middle East) keep business-as-usual.

In the subsequent sections we will discuss the impact of all 5 scenarios separately on the mentioned topics. We will start each section with a summary of the result after which a more detailed explanation of the results per scenario is given.

3.2.1 GDP

Table 29 gives a GDP forecast for 2030 for the baseline, and the impact on GDP in % of the measures in a scenario with respect to the baseline.

The actions in the SRIA have a positive impact on gross domestic product. *The increase in GDP is almost exclusively due to the actions that belong to 'Circular Industries'. Some actions result in measures that cause efficiencies in the industries. Energy efficiency measures and reduction of use of materials by re-using or leasing the materials cause efficiencies in these industries. This is in turn beneficial for the profitability of these industries, and causes GDP to increase.*

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Box 2: Definition of GDP

Box 2: Definition of GDP

In order to explain the results, let us first explain the definition of GDP. For this we use the income and the production definition of GDP. First, let us explain the building blocks of GDP:

Intermediate production costs (IO) = production costs that industries spend on goods from other industries.

Wages (L) = Costs of industries spend on wages, which is income for households.

Capital costs (K) = Capital expenditures of industries.

Firm profits (P) = Profits of industries.

Final value of all goods and services (Y) = Total value of the economy, this is the sum of intermediate production costs (IO), wages (L), Capital costs (K) and firms profits (P). Total value of all goods and services is also equal to total revenue of products sold by domestic industries.

Income definition: GDP = L+P+K .
Production definition: GDP = Y-IO.

Measures in 'Circular Industries' have a positive effect on GDP compared to the baseline. For example, in the business-as-usual situation, the EU in total has an expected total GDP of 14.9 billion euro in 2030. When the actions under 'Circular Industries' are implemented, it is expected that GDP in the EU lies 3.9% higher than GDP in the business-as-usual situation in 2030.

The higher GDP under scenario 'Circular Industries' can be explained as follows. Some of the measures in 'Circular Industries' result in efficiencies in industries. That is, energy efficiency measures directly cut production costs. Furthermore, manufacturing sectors are assumed to use less materials, i.e. materials that could be avoided and do not have to be replaced by recycled products. This results in a reduction of production costs that industries spend on other industries (IO) (see Box 2 with explanation on GDP). When value of goods sold remain the same, intermediate production costs decrease, and profit and spending on labour increase. Some industries will sell more goods because the production cost reduction make them more efficient, resulting in a lower price which increases the demand of goods from that industry. On the other hand, there are also industries that produce goods or services (energy service) for which demand decreases due to circular economy measures. Table 50 in Annex B show which industries benefited from the measures in circular economy, and which ones did not.

It is found that measures in scenarios 'Circular Cities' and 'Closing the Loop' have very little impact on GDP. The measures in these scenarios do not result in a cut in the production cost of industries. For many of the measures in these scenarios, a decrease in use of one product group is replaced by the use of another product group, e.g. secondary materials instead of raw materials. Although this has great effects on the industries producing these products, these effects cancel out when calculating the GDP, resulting in only a slight change. The changes per industry can be found in Table 41 and Table 59 in Annex B.

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There is also a negligible change in GDP for 'Resource Efficiency on Territory and Sea'. The industries mainly effected by the measures from this scenario are the fishery industry and the marine transportation industry. These industries are small compared to other industries, resulting in a negligible change for the GDP. The changes for the individual industries are significant, as can be seen in Table 68 in Annex B.

The combined scenario, that contains all measures implemented in the four joint programmes, shows a growth in GDP. The measures in the 'Circular Industries' scenario are the main drivers of this economic growth in the EU.

Note that the increases and reductions in GDP in the four JP scenarios do not exactly match the increase in GDP in the combined scenario. As explained in beginning of Section 3.2, this is due to the stacking of different measures from the different scenarios, and partly due to rebound effects within the model.

Also note that we assumed that all EU-regions implemented similar measures in relative terms, for example, reduce raw material use in some sectors with 25%. However, the economic structure of these EU-regions differ. Therefore, some regions with relatively large industries that benefit from the measures shall undergo a faster increase in value of the economy (in % with respect to the baseline without any CE measures).

Table 29 GDP forecast in million euro for 2030 for the baseline in 2030 and the effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline in mln euro (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	1,302,153	0.0%	4.4%	0.1%	0.0%	4.0%
South-EU	3,834,979	0.0%	4.3%	0.0%	0.0%	4.1%
West-EU	8,214,568	-0.1%	3.7%	0.0%	0.0%	3.4%
East-EU	1,554,146	0.1%	6.7%	0.1%	0.0%	6.5%
EU	***14,905,846***	***0.0%***	***4.2%***	***0.0%***	***0.0%***	***3.9%***

Figure 17 is added for clarity and completeness. This figure gives GDP forecast for two scenarios: the business-as-usual scenario and the scenario with all Joint Programmes implemented. The situation in 2030 is most interesting (as is also given in Table 29). It shows that in 2030, the GDP of the scenario with the SRIA implemented lies 3.9% above the level of GDP in the business-as-usual scenario.

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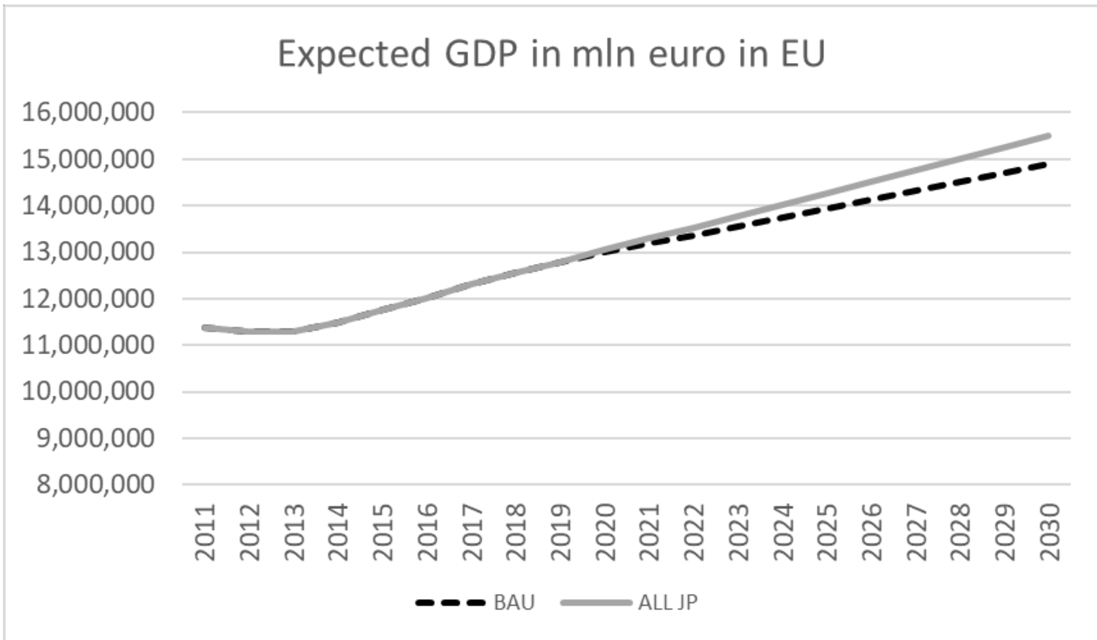

Figure 17: GDP forecast in million euro for 2011-2030 for the EU. Two scenarios are compared: business as usual and the scenario with all Joint Programs implemented.

3.2.2 Employment

Table 30 shows the results for the total employment in the different regions. This table shows that extra jobs are created in the scenario 'Circular Industries'. For the other three scenarios, total employment does not increase, however employment shifts between the industries take place. This section describes the employment shifts that are found per scenario.

> ***There is some job creation due to the actions described in the SRIA.*** *More important, jobs are expected to shift among the industries. Some sectors diminish in size and are therefore expected to lose jobs and other are expected to be winners due the described actions. Extra jobs are created in industries that focus on leasing activities, reprocessing of secondary materials, renewable energy industry. Industries where jobs are lost are those industries that are dependent on extraction of raw materials, or electricity generated by fossil fuels. Also jobs related to meat production shall diminish over time according to our analysis.*

Table 30 should be read as follows: under the scenario in which the SRIA is implemented there are 2% more jobs in 2030 compared to the business-as-usual scenario in which there are 209.8 million jobs in 2030 in the EU.

For 'Circular Industries' extra jobs are created in the leasing and service sectors while jobs are lost in manufacturing sectors that produce machinery and electrical equipment. Extra jobs are created in the leasing sector, due to the measure that manufacturing industries shift from owning equipment towards leasing equipment. The shift from electricity produced by fossil fuels to renewables causes jobs to be lost in the electricity sectors that produces electricity from coal, gas and petroleum, while jobs are created in green electricity sectors. Further in the value chain, jobs are lost in the industries

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that mine fossil fuels. More biobased chemicals increase employment in agricultural industries. Some jobs are also- lost in the sector that produces paper products, which is explained by further digitalization of service sectors.

For 'Circular Cities' extra jobs are created in the agriculture and fishing sector, but lost in the livestock and food retailer sector. This is due to measurements which cause households and food producing industries to waste less food, so consuming less and becoming more efficient. Also, households will switch from meat to a more plant-based diet. Sectors that produce reprocessed materials have higher employment at the expense of the sectors that produce the raw materials which are being replaced. This shift occurs as a result of more recycling municipal waste and construction and demolition waste. As in 'Circular Industries' extra jobs are created in the leasing and service sectors while jobs are lost in manufacturing sectors that produce machinery and electrical equipment, this is due to the measure that households also start leasing household equipment and machinery like cars.

Scenario 'Closing the Loop' includes two types of measures: measures that impact the production structure of sectors in the EU, and measures that change the location of materials used in European production processes (e.g. domestic versus imported). The latter causes an increase in employment in the European waste processing sector because materials are not exported to regions outside the EU and waste needs to be processed within the EU. Also, one of the measures in this scenario assumes that less primary raw materials will be imported from abroad. This causes a slight increase in the mining industry in the EU. Measures that impact the production structure of sectors in the EU cause an increase in employment in the reprocessing sectors and a decrease in sectors that provide primary raw materials, or are closely connected to sectors that provide primary raw materials. The effect of total employment due to measures in this scenario is very small, but slightly positive.

For 'Resource Efficiency on Territory and Sea' the only industry which has a significant change in employment in the fishery sector. The industry will reduce its waste, making it more efficient. Consequently, the industry grows, causing an increase in employment. However, this is a small sector, so the change of total employment is negligible.

Table 30 Employment forecast in 1000p for 2030 for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline in 1000 p (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	13,951	0.1%	1.6%	0.1%	0.0%	1.7%
South-EU	54,268	0.5%	1.3%	0.0%	0.0%	1.8%
West-EU	94,615	0.4%	1.2%	0.1%	0.0%	1.6%
East-EU	46,972	0.9%	2.3%	0.1%	0.0%	3.2%
EU	***209,806***	***0.5%***	***1.5%***	***0.1%***	***0.0%***	***2.0%***

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3.2.3 Greenhouse gas emissions

***Greenhouse gas emissions will be reduced due to the energy efficiency measures and shift towards renewable energy**. Though the SRIA places the focus on the decoupling of economic growth from raw materials, some measures are implemented that are more directly aimed at reducing GH emissions. We find that greenhouse gas emissions are about 30% lower in 2030 in the scenario where all joint program actions are implemented compared to the baseline.*

Table 31 and Table 32 give production and consumption based emissions respectively. Figure 18 gives in addition a graphical illustration of the information in Table 31. Where Table 31 focusses on differences with the baseline in year 2030, Figure 18 shows the difference with the baseline for every year between 2011-2030. In 2030 it is found that greenhouse gas emission emitted within the EU are 28.9% lower in the SRIA-scenario, compared to the baseline.

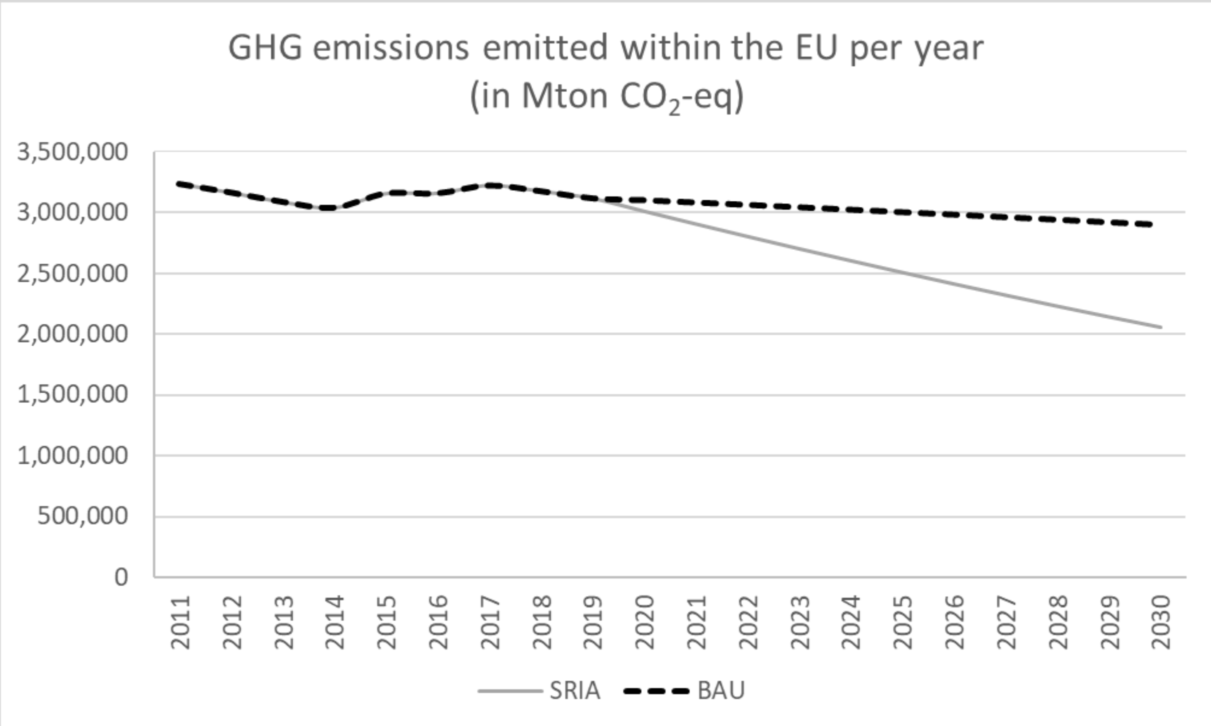

Figure 18: 'Production based' greenhouse gas emissions in Megaton CO_2-equivalents for 2011-2030. Greenhouse gases include CO_2, NO_2 and CH_4 emissions.

Where Figure 18 and Table 31 show the impact of circular measures on the *production* based definition of GHG emissions, Table 32 shows the impact on the *consumption* based definition of GHG emissions (For exact definitions of these two definitions we refer to the section with 'Definitions and acronyms', page 10).

In general, for developed countries production based emissions are lower than consumption based emissions. These countries are net-importers. From all goods consumed, the biggest share of emissions from the production processes have been emitted abroad. Only for East-European countries the difference between production based and consumption based emissions is low. This can be explained by the GDP/capita in these counties. Compared to North-EU and South-EU, these

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countries have themselves still relative low incomes and do not import as many goods from abroad. Production based GHG emissions decrease faster than consumption based emissions. The circular economy and energy transition measures only apply to the industries within the territory of the EU. Therefore it directly affects emissions for which EU-industries are responsible. Goods purchased by households and governments in the EU are likely to be produced using both electricity on the territory of the EU, as well as electricity (and other energy sources) in production processes outside Europe. Therefore, when consumption based emissions are considered as measure, emissions also decrease, but not as fast as under the measure production based emissions.

Table 31 should be read as follows: under the scenario in which the SRIA is implemented there are 28.9% less greenhouse gas emission emitted in 2030 compared to the business-as-usual scenario in which there are 2,898,046 Megaton emissions emitted in 2030 in the EU region.

For 'Circular Cities' the largest production based GHG-emission reduction is seen in the livestock sector. This is partly cancelled by an increase in GHG-emission in the agriculture sector. These changes are due to less food waste and a shift from a meat-based to a plant-based diet. However, the GHG emission are a lot higher for the livestock sector due to methane, resulting in an overall decrease. In this scenario there is a shift to using secondary materials instead of raw materials, causing decreases of GHG-emissions in the sectors that produce raw materials and increases of GHG-emissions in the sectors that produce secondary materials. However, the increase is far smaller than the decrease, so overall there is a decrease. The largest consumption based GHG-emission reductions can be found for the products related to food.

'Circular Industries' scenario has the largest GHG-emissions reductions – both in the consumption based definition as in the production based definition. This reduction can for a very large part be explained by the energy efficiency measures and changes in electricity mix from fossil-fuel based electricity to renewables. For the production based definition, the energy efficiency measure alone results in an approximate decrease 15% greenhouse gas emissions. Shifting to renewable energy sources adds approximately 5% reduction to this number. Other measures in this scenario – like shift towards biobased chemicals, shift towards leasing rather than owning a product, reduction of industrial waste and reduction of primary raw materials – add about 2-3% to the reduction of greenhouse gas emissions.

The measures in 'Closing the Loop' have a negligible effect on the greenhouse gas emissions emitted within the own territory (production based definition), and a slightly reducing effect on emissions under the consumption based definition. Especially the aim of the EU to not export waste and keep reprocessing production processes within the territory of the EU results in an increase of economic activity within the EU, and thereby also increases the emissions emitted within its own territory. Emissions emitted in the whole supply chain of products finally purchased within the EU reduce due to measures in this scenario, since also virgin raw materials are now coming from within the territory of the EU. The EU mining and production processes of virgin raw materials are cleaner compared to importing these materials from abroad. This results in small reduction in the consumption based GHG-emissions.

For 'Resource Efficiency on Territory and Sea' the largest reduction of GHG-emissions are for the marine transportation service industries. This is caused by a decrease in fossil fuel use. There is a great difference in reduction between the regions. In the region North-EU, marine transportation service industries are responsible for a large share of the total GHG-emissions. Consequently, in this region a reduction of GHG-emissions emitted by marine transportation services has a larger impact on total GHG-emissions in that region, compared to other regions.

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The other measure in 'Resource Efficiency on Territory and Sea' is the valorisation of waste in the fishing industry. Due to this measure, the industry becomes more efficient. This has two main effects. First, per unit output there are less GHG-emissions. Secondly, the prices decrease and the output increases. The first effect causes a decrease of GHG-emissions and the second effect causes an increase. In total there is a net small reduction of GHG-emissions by fishery.

Under the consumption based definition, largest reduction is again for the use of marine transportation services. Also the value chain behind other products are expected to have a reduction in emissions due to the measures in 'Resource Efficiency on Territory and Sea'. Almost all product groups use transportation in their value chain. Consequently, every product benefits from the GHG-emission reductions in the transport sector.

Table 31 'Production based' greenhouse gas emissions in megaton CO_2-equivalents for 2030 for the baseline in 2030 and effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline in Mton in CO_2-eq (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	184,266	-7.1%	-21.2%	2.2%	-4.3%	-29.5%
South-EU	652,984	-6.1%	-21.9%	1.1%	-0.7%	-27.2%
West-EU	1,256,657	-6.9%	-22.4%	0.1%	-0.5%	-29.1%
East-EU	804,138	-3.3%	-27.0%	0.2%	0.0%	-29.8%
EU	***2,898,046***	***-5.7%***	***-23.5%***	***0.5%***	***-0.7%***	***-28.9%***

Table 32 'Consumption based' greenhouse gas emissions in megaton CO_2-equivalents for 2030 for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline in Mton CO_2-eq (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	265,971	-3.5%	-16.6%	-1.4%	-1.4%	-23.2%
South-EU	870,101	-4.0%	-18.9%	-1.5%	-0.4%	-24.4%
West-EU	1,616,234	-4.1%	-19.7%	-2.2%	-0.2%	-25.1%
East-EU	775,989	-2.2%	-21.9%	0.3%	0.0%	-24.6%
EU	***3,528,296***	***-3.6%***	***-19.8%***	***-1.4%***	***-0.3%***	***-24.7%***

The model also yields the expected **cumulative** CO_2 emissions from the base year of our model/ simulation until 2030. This line is shown as a black dashed line in Figure 19. This line looks more or less linear, which matches with the black dashed line in Figure 18. Namely, yearly, in the baseline, the amount of GHG emissions barely decreases. Cumulatively, this gives a linear line.

Figure 19 also gives the yearly cumulative CO_2 emissions in the SRIA scenario. As was apparent from Table 31, only measures implemented under JP 'Circular Industries' have a significant impact on the reduction of GHG emissions within the territory. That is, the scenario with the SRIA implemented has

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between 2020 and 2030 about 15% less cumulative greenhouse gas emissions emitted compared to the baseline.

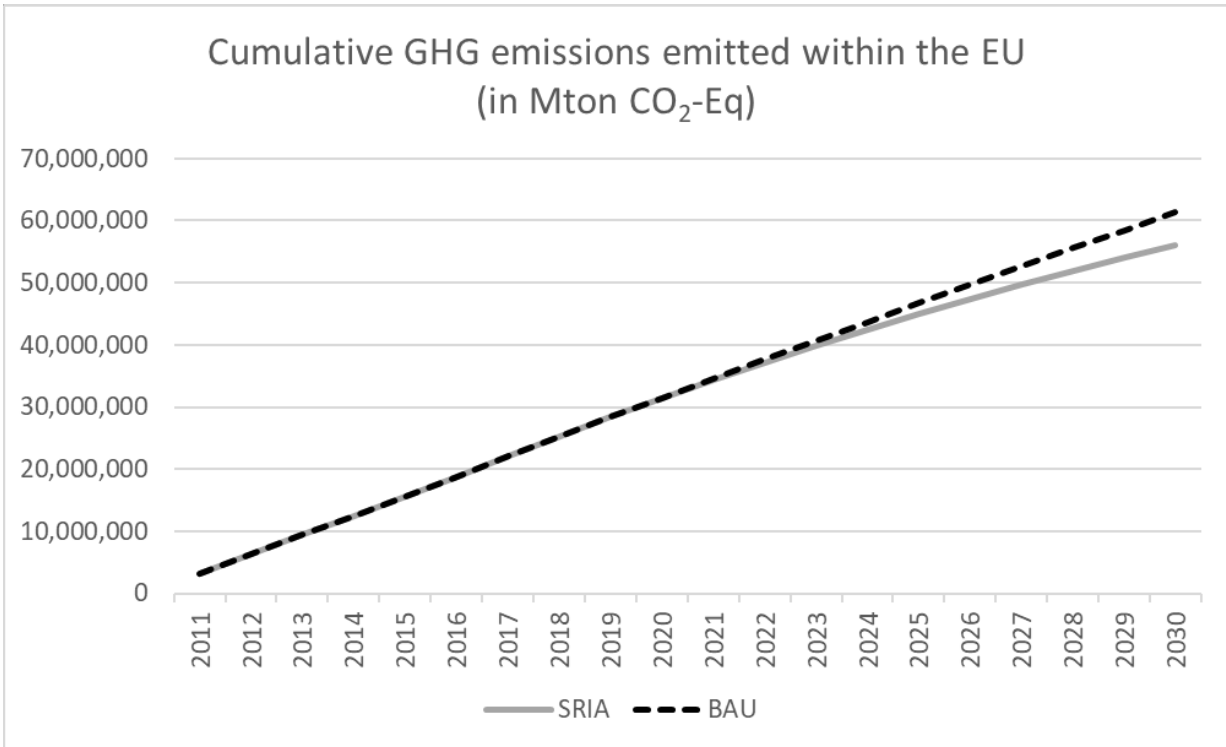

Figure 19: Cumulative 'production based' greenhouse gas emissions in Megaton CO_2-equivalents for 2011-2030 in the EU for the baseline. For scenarios 'Circular Cities', 'Circular Industries', 'Closing the Loop', and 'Territory and Sea' the cumulative reduction of greenhouse gas emissions is shown in this figure.

Historically, there has been a correlation between the growth of GDP and the growth of GHG emissions. Figure 20 shows an index of GDP and 'production based' GHG emissions for the baseline and the combined scenario. In the baseline, until 2017 there is a strong correlation between GDP and GHG emissions. After 2017 a decoupling starts taking place. This decoupling assumption is part of our baseline assumptions (see left panel of Table 20). For the combined scenario this decoupling is seen from 2019. Furthermore, the decoupling is much stronger.

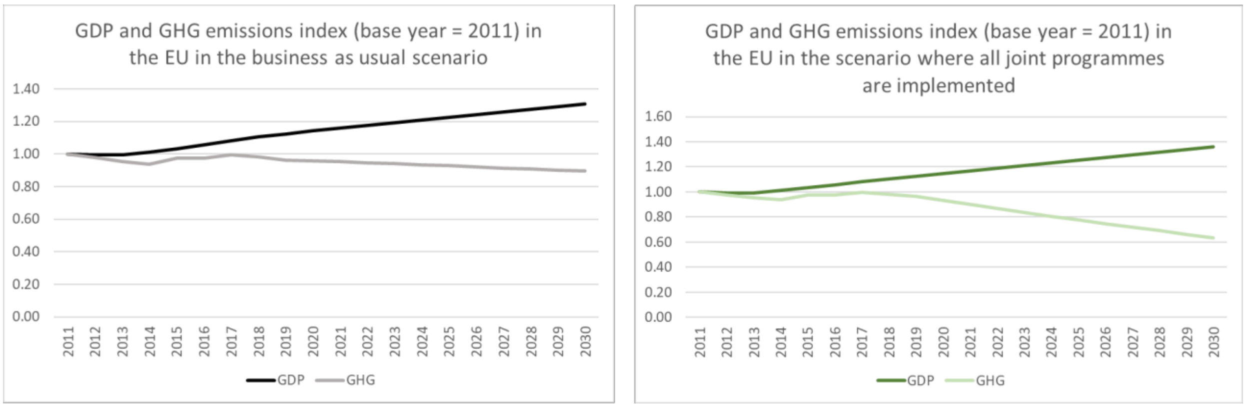

Figure 20 Index of GDP and 'production based' GHG emission, with base year 2011, for 2011-2030 in the EU for the baseline and the combined scenario.

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The EU and many European countries have set targets for GHG emission reductions for 2030. In September 2020 the European Commission has proposed to raise a target of 40% GHG emission reduction in 2030, from 1990 levels, to 55% (European Commission, 2020e). In the baseline a 29% reduction is achieved, from 1990 levels, while the combined scenario achieves a 49% reduction[12], which suggests that full implementation of the SRIA measures covers a significant part of the EU emission reduction ambitions.

3.2.4 Raw material use

As explained in Section 3.1.4, raw material use is defined in this report as Domestic Extraction Used. The OECD definition defines DEU as "*the flows of raw materials extracted or harvested from the environment and that physically enter the economic system for further processing or direct consumption (they are used by the economy as material factor inputs).*"

***All Joint programs contribute to diminishing raw material use**. The report distinguished five types of raw material: wood, other biomass, fossil fuels, non-metallic minerals and metals. Especially the extraction of non-metallic minerals and metals are expected to decrease due to the R&I actions described in the SRIA. Extraction of these materials decrease – depending on the region – between 22%-42% in 2030 compared to the business-as-usual situation in 2030.*

Table 33 and Table 34 give production based and consumption based raw material used (For exact definitions of these concepts we refer to the section with 'Definitions and acronyms', page 10). As for emissions, the production based material extracted decrease more than the consumption based material extracted, because the circular economy and energy transition measures only apply to the industries within the territory of the EU.

Table 33 should be read as follows: under the scenario in which the SRIA is implemented there is 17.7% less biomass material extracted within North-EU in 2030 compared to the business-as-usual scenario in 2030, for 77,984 kiloton biomass will be extracted in 2030 in North-EU region.

Looking at the scenario 'Circular Cities', Table 33 and Table 34 show a decrease in the use of biomass. This is mostly due to the measure where by 2030 we should halve our food waste. This basically implies that less agricultural products are needed to feed the same amount of people. This efficiency is noticeable in the use of biomass. On the other hand, there is another measure that assumes that we should increase our plant-based consumption and reduce our intake of meat. This measure has an upwards effect on the use of biomass. (For definition on biomass, see Table 38 in Annex B). Use of wood decreases as well under this scenario because households are more efficient with paper products.

The reduction in non-metallic minerals and metals in scenario 'Circular Cities' is mostly due to the construction and demolition related measures. This measure assumes an increase of Construction and Demolition waste prepared for re-use or recycling from 70% in 2020, to 90% in 2030. Construction and demolition waste is not enough to cover the majority of material needs in the construction sector. Therefore there are modest decreases in non-metallic minerals and metal ores.

[12] In 1990 the GHG emission levels of the EU-27 were 4,061 Mton. In 2030 the GHG emissions are projected to be 2,898 Mton in the baseline and 2,061 Mton in the combined scenario. These are reductions of 29% and 49%, respectively.

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Note that no energy efficiency measures are assumed under the scenario “Circular Cities”, therefore, reduction in fossil fuels are limited.

For scenario ‘Circular Industries’, the measures have either a minor positive or a minor negative impact on the biomass used in the value chain of products purchased by citizens of the EU (consumption based definition) and all materials used within production processed in the EU (production based definition). An increase is mostly due to the increase in use of biobased chemicals, which is assumed to use more input from the agricultural sector. However, in south- and west-EU, we find that the use of biomass is slightly decreasing. This is mostly due to the measures that assumes all raw materials as input to production processes are decreasing. The product group ‘Textile and Wood’ is also a raw material that will diminish over the years for all industries. The industry that produces this product group also uses a lot of agricultural products further along in the value chain. This decreases the use of biomass over the years. Thus, there are two counteracting effects, in some region the positive effect dominates, whereas in other regions the negative effect on biomass consumption dominates.

The use of wood is decreasing for ‘Circular Industries’. This is mostly due to the measure that assumes that service sectors are assumed to use less paper-products, which has a decreasing effect on the use of wood. This scenario also assumes that energy efficiency of all industries is improved by 32.5%, also the share of renewable energy should be at least 32% in 2030. Therefore, the use of fossil fuels decreases significantly.

There are three aggregated measures in ‘Circular Industries’ that have most effect on the use of metal and non-metallic mineral materials. That is: (1) reduction of industrial waste , (2) all industries are reusing / repairing machinery rather than replacing the machinery and electrical equipment and (3) raw materials are being replaced by reprocessed materials.

All material uses are decreasing due to other measures in scenario ‘Closing the loop’. The decrease in biomass and wood can be explained by a decrease in use of product group ‘textile and wood products’ by other industries. This product group is defined as a primary raw material group of which other industries should use less over the years. The reduction of this industry is compensated by an increase in reprocessed textile and wood products. However, since the industry that produces this reprocessed product does not need any raw materials as input, this increase is not visible in Table 33 and Table 34.

The same holds for metals and non-metallic minerals. Especially due to the measures in ‘Closing the Loop’ that increases urban mining and reduce primary raw materials in complex products, it is expected that in 2030 there are less raw metals and non-metallic minerals extracted for production processes in the EU. Note that the measure that more virgin raw materials should originate from the EU, has a slight increasing effect on future metal and non-metallic mineral extracted in the EU.

The measure where the government invests in better data systems to support circularity has almost no effect on all materials extracted within the EU (production based definition), or used within the value chain of products purchased by consumers in the EU (consumption based definition).

Similar to what was explained for ‘Circular Industries’, also ‘Closing the Loop’ does not include energy efficiency measures, which explains the minor reductions in raw fossil fuels. Reduction of this materials are indirectly achieved via the measures in this scenario.

For the scenario ‘Resource Efficiency on Territory and Sea’ the effects on material use are negligible. Most could be expected for the use of fossil fuels, as the marine transport sector will start using

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renewables instead of fossil fuels. However, this sector only uses a small share of total fossil fuels used, so the effect becomes negligible.

Table 33 'Production based' raw material use in kton for 2030 for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

Material	Region	Baseline in kton (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
Biomass	North-EU	77,984	-19.6%	2.6%	0.0%	0.1%	-17.7%
	South-EU	214,334	-10.1%	-3.1%	-1.1%	0.0%	-13.3%
	West-EU	509,670	-15.6%	-2.0%	-0.9%	0.0%	-18.3%
	East-EU	368,393	-3.4%	0.4%	-0.3%	0.0%	-2.8%
	EU	***1,170,382***	***-11.0%***	***-1.1%***	***-0.7%***	***0.0%***	***-12.5%***
Wood	North-EU	97,090	-6.1%	-12.3%	-5.9%	0.0%	-21.0%
	South-EU	25,122	-6.3%	-3.0%	-3.0%	0.0%	-10.1%
	West-EU	69,165	-2.0%	-2.6%	-1.0%	0.0%	-4.6%
	East-EU	83,170	-5.4%	-4.2%	-0.6%	0.0%	-10.2%
	EU	***274,547***	***-4.9%***	***-6.6%***	***-2.8%***	***0.0%***	***-12.6%***
Fossil fuels	North-EU	28,144	-1.5%	-16.7%	-0.5%	-0.1%	-18.4%
	South-EU	71,624	-9.3%	-12.9%	0.4%	0.0%	-20.4%
	West-EU	267,271	-1.5%	-18.4%	-0.8%	0.0%	-19.6%
	East-EU	414,412	-0.7%	-17.7%	0.8%	0.0%	-17.0%
	EU	***781,451***	***-1.8%***	***-17.5%***	***0.2%***	***0.0%***	***-18.2%***
Non-metalic minerals	North-EU	324,785	-7.3%	-20.3%	-8.1%	0.0%	-22.9%
	South-EU	823,412	-14.5%	-24.8%	-13.1%	0.0%	-33.8%
	West-EU	1,234,535	-14.5%	-34.6%	-16.6%	0.0%	-40.9%
	East-EU	1,177,212	-8.9%	-26.1%	-5.8%	0.0%	-30.3%
	EU	***3,559,945***	***-12.0%***	***-28.2%***	***-11.5%***	***0.0%***	***-34.1%***
Metal ores	North-EU	93,348	-7.8%	-21.8%	-8.7%	0.0%	-24.5%
	South-EU	22,255	-14.5%	-25.0%	-13.4%	0.0%	-34.0%
	West-EU	7,364	-14.5%	-35.0%	-16.8%	0.0%	-41.3%
	East-EU	72,995	-9.2%	-26.9%	-6.0%	0.0%	-31.3%
	EU	***195,962***	***-9.3%***	***-24.5%***	***-8.5%***	***0.0%***	***-28.7%***

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Table 34 'Consumption based' raw material use in kton for 2030 for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

Material	Region	Baseline in kton (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
Biomass	North-EU	118,091	-7.3%	1.9%	-1.8%	0.0%	-8.0%
	South-EU	421,009	-3.2%	0.7%	-2.2%	0.0%	-3.2%
	West-EU	789,575	-3.2%	-1.4%	-2.6%	0.0%	-5.8%
	East-EU	406,540	-1.9%	3.6%	-0.6%	0.0%	1.5%
	EU	***1,735,215***	***-3.2%***	***0.5%***	***-2.0%***	***0.0%***	***-3.6%***
Wood	North-EU	84,757	-6.3%	-13.3%	-3.0%	0.0%	-18.7%
	South-EU	49,680	-5.9%	-6.2%	-7.5%	0.0%	-13.1%
	West-EU	139,275	-3.3%	-4.6%	-3.8%	0.0%	-8.7%
	East-EU	73,932	-4.5%	-2.2%	0.6%	0.0%	-5.6%
	EU	***347,644***	***-4.6%***	***-6.5%***	***-3.2%***	***0.0%***	***-11.1%***
Fossil fuels	North-EU	160,172	0.8%	-15.6%	-2.2%	0.0%	-17.5%
	South-EU	529,464	-1.3%	-15.5%	-2.8%	0.0%	-18.9%
	West-EU	961,614	-0.7%	-17.8%	-3.5%	0.0%	-20.8%
	East-EU	599,123	1.2%	-13.9%	0.6%	0.0%	-12.8%
	EU	***2,250,373***	***-0.2%***	***-16.1%***	***-2.2%***	***0.0%***	***-18.0%***
Non-metalic minerals	North-EU	409,604	-6.7%	-22.2%	-9.1%	0.0%	-26.3%
	South-EU	1,251,468	-11.4%	-25.5%	-12.4%	0.0%	-33.7%
	West-EU	2,153,127	-10.8%	-31.5%	-14.5%	0.0%	-38.5%
	East-EU	1,063,609	-8.2%	-26.0%	-7.1%	0.0%	-29.8%
	EU	***4,877,807***	***-10.0%***	***-28.0%***	***-11.9%***	***0.0%***	***-34.4%***
Metal ores	North-EU	97,751	-7.3%	-22.8%	-10.8%	0.0%	-27.4%
	South-EU	111,928	-6.1%	-28.0%	-18.3%	0.0%	-39.9%
	West-EU	203,877	-4.0%	-29.2%	-17.3%	0.0%	-39.0%
	East-EU	95,925	-6.5%	-27.3%	-10.8%	0.0%	-33.5%
	EU	***509,481***	***-5.6%***	***-27.3%***	***-15.0%***	***0.0%***	***-35.9%***

3.2.5 Secondary material use

Secondary material use data has been collected for this project. A description of the collected data and definition of 'secondary material use' can be found in Annex A.4. Similar to our definition for raw material use, secondary material use refers to 'extracted' or 'produced' materials within the EU.

The actions in the SRIA cause a larger demand for secondary materials. *For secondary materials, data for four material types for the base year has been extracted from Eurostat: biomass, fossil fuels, non-metallic minerals and metals. Especially demand for non-metallic minerals and metals shall increase. This is due to the actions that assume industries should reduce the input of primary raw materials in production processes and replace this input by secondary materials. There are a selection of implemented measures that contribute to this result. For example urban mining, reduction or urban and industrial waste, reduction of primary raw materials.*

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Table 35 shows the extraction/ production of secondary materials in the four EU regions. Note that we only show the production based definition of secondary materials. This is because we only have data (in kton) of secondary materials for EU regions. For regions outside the EU we do not know the extraction of secondary materials. Secondary material used further along in the value chain for products consumed in the EU (e.g. consumption based definition), is therefore not a very interesting result to show.

In this section, we will discuss the effect of each scenario on the different types of secondary material.

For the scenario 'Circular Cities' there is a decrease of biomass used. This is caused mostly by the reduction of food waste. The change of fossil fuels used is small, because there are no specific measures for energy efficiency in this scenario. There is an increase for non-metallic minerals and metal ores. These are caused by measures due to which industries will start using secondary materials instead of raw materials.

The effects of the measures in scenario 'Circular Industries' on secondary biomass is limited. As one of the measures foresees a shift towards biobased chemicals, the demand for biomass material increases, and thereby also secondary biomass material. The decreasing demand for secondary fossil fuel material can be explained by the energy efficiency measures and the shift towards renewable energy. This results in a decrease of all fossil fuel inputs, and thereby also secondary material input. There is no additional measure that assumes that the share of secondary fossil fuels should increase relative to raw fossil fuel inputs of industries. Therefore, for both, a decreasing trend is observed with respect to the baseline.

The use of secondary non-metallic minerals and metal ores on the other hand are expected to increase quite heavily compared to the baseline. In North-EU, it is expected that in 2030, there is 2,44 times more demand for non-metallic minerals compared to the baseline in 2030 of 48,251 kiloton. This is mostly due to the measures that primary raw materials (like metals, paper and wood products, non-metallic minerals) are replaced by secondary materials in the production processes.

The measures defined for 'Closing the Loop' have very little impact on the secondary materials Biomass and Fossil Fuels. The latter one especially because no energy efficiency measures are assumed for this scenario. Similar to scenario 'Circular Industries', the increase in secondary non-metallic minerals can be explained due to the increase in use of primary raw materials (metals, paper and wood products, construction products and non-metallic minerals) in production of complex products. Also urban mining enables industries to use more secondary materials in their production processes.

For the scenario 'Resource Efficiency on Territory and Sea' there are no significant changes in secondary material use.

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Table 35 'Production based' secondary material use in kton for 2030 for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

Material	Region	Baseline in kton (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
Biomass	North-EU	2040	-19.6%	2.6%	0.0%	0.1%	-17.7%
	South-EU	3836	-10.1%	-3.1%	-1.1%	0.0%	-13.3%
	West-EU	9339	-15.6%	-2.0%	-0.9%	0.0%	-18.3%
	East-EU	9571	-3.4%	0.4%	-0.3%	0.0%	-2.8%
	EU	***24,785***	***-10.4%***	***-0.9%***	***-0.6%***	***0.0%***	***-11.5%***
Fossil fuels	North-EU	167	-1.5%	-16.7%	-0.5%	-0.1%	-18.4%
	South-EU	326	-9.3%	-12.9%	0.4%	0.0%	-20.4%
	West-EU	815	-1.5%	-18.4%	-0.8%	0.0%	-19.6%
	East-EU	291	-0.7%	-17.7%	0.8%	0.0%	-17.0%
	EU	***1,599***	***-2.9%***	***-17.0%***	***-0.2%***	***0.0%***	***-19.1%***
Non-metalic minerals	North-EU	48251	135.9%	166.2%	86.7%	0.0%	243.7%
	South-EU	85844	14.4%	25.9%	22.5%	0.0%	36.3%
	West-EU	227179	9.3%	69.2%	28.8%	0.0%	50.8%
	East-EU	110644	39.6%	92.7%	40.1%	0.0%	108.5%
	EU	***471,918***	***30.3%***	***76.8%***	***36.3%***	***0.0%***	***81.4%***
Metal ores	North-EU	8228	9.2%	54.6%	40.0%	0.0%	62.1%
	South-EU	14639	0.6%	10.0%	24.6%	0.0%	24.9%
	West-EU	38567	-0.8%	20.6%	19.8%	0.0%	21.6%
	East-EU	13947	3.3%	53.7%	31.2%	0.0%	63.3%
	EU	***75,381***	***1.3%***	***28.4%***	***25.1%***	***0.0%***	***34.4%***

We found that *secondary* material use is increasing in 2030 with respect to the baseline in 2030, and *raw* material use is decreasing in 2030 with respect to the baseline in 2030. Figure 21 shows that *total* material is lower in the scenario with all actions in the SRIA implemented. The share of secondary material use with respect to total material use also increases.

Note that all results are generated under the assumption that GDP is growing according to projections for the next ten years. An increase in GDP still implies an increase in material use, despite that the next section will show that Extracted Resource Productivity is improving. The aim to improve welfare over the years, restrains the reduction in material use.

For some measures implemented we are relying on maximum amount of waste available for recycling and using as secondary materials. For the building sector for example it is known that due to the higher demand for buildings in the future, theoretically, only 35% of all newly build building can be created from secondary material demand (Smedley, 2020). This is an example of a scenario input that restricts the reduction of raw material use due to the assumption of every growing economy.

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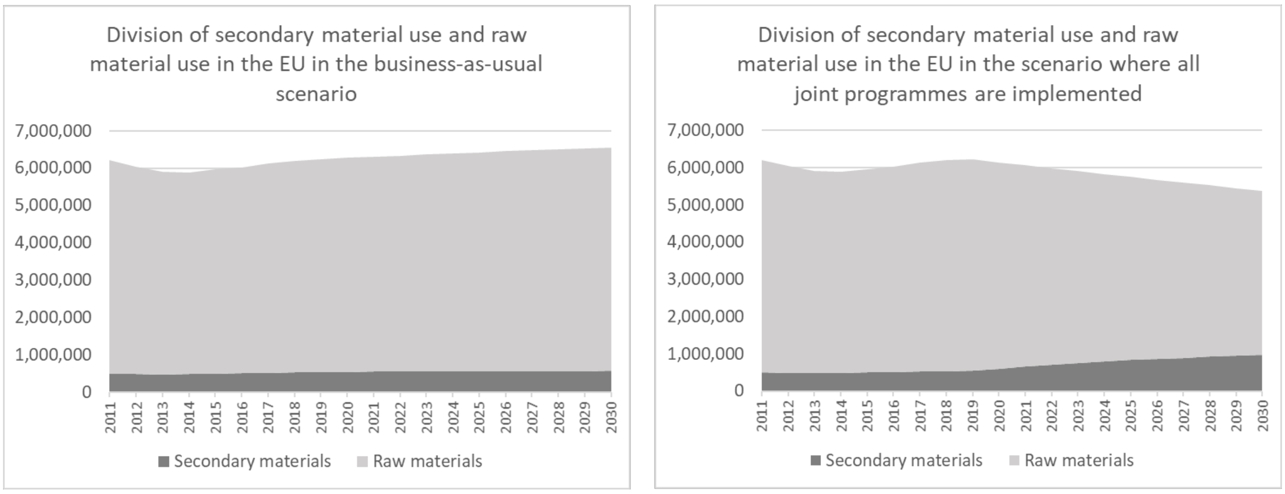

Figure 21: 'Production based' total material use in kilotonnes for 2011-2030 for the baseline and the scenario that includes all actions in all joint programmes in the EU.

3.2.6 Extracted Resource Productivity

Recall that Extracted Resource Productivity (ERP) is defined as Gross Domestic Product (GDP) divided by Domestic Extraction Used (DEU). See the section with 'Definitions and acronyms' for exact definition. Only raw material use is included in the calculation, not secondary material use. Extracted Resource Productivity should ideally increase over years. For interpretation, with the same material input a higher economic growth can be achieved. Or, similarly, the same economic growth can be achieved with less use of material.

> ***Extracted Resource Productivity is expected to increase in the scenario where the SRIA is implemented.***
> *This is due to the expected increase in GDP and expected decrease of raw materials due to the implemented actions from the SRIA. That is, the actions help in the decoupling of GDP and raw material use. However, despite that the SRIA contributes to a more positive looking Extracted Resource Productivity. We should still be critical on whether this increase is large enough to prevent future exhaustion of natural resources this planet has to offer.*

The baseline, without circular economy and energy transition measures show already an increasing extracted resource productivity. Table 36 shows that the scenarios 'Circular Cities', 'Circular Industries' and 'Closing the Loop' further increase extracted resource productivity. The largest increase comes from 'Circular Industries'. The scenario 'Resource Efficiency on Territory and Sea' has no significant change on ERP.

For the scenario 'Circular Industries' it is mostly the reuse or leasing of electrical equipment and machinery like cars that cause extracted resource productivity to grow. This measure has a positive impact on economic growth and a decreasing effect on material use. Other measures in 'Circular industries' mostly have a decreasing effect material use (see Section 3.2.4).

For the scenarios 'Circular Cities' and 'Closing the Loop' the measures do not result in an increasing GDP (see Section 3.2.1), however, they do result in diminishing material use. Therefore, extracted resource productivity is also increasing for these scenarios.

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Note that the increase in extracted resource productivity is such steep because for most measures in the scenarios, primary raw materials are replaced by secondary materials. And secondary materials are not included in the definition of extracted resource productivity.

Since the scenario 'Resource Efficiency on Territory and Sea' has no significant effect on GDP and material use, it has no effect on the extracted resource productivity.

Table 36 Extracted Resource Productivity in euro GDP / kton DEU for the baseline in 2030. The effect (in %) of the measures in four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline in euro/kton (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	2.10	9.3%	24.6%	7.1%	0.0%	33.3%
South-EU	3.32	15.2%	29.7%	10.9%	0.0%	45.9%
West-EU	3.93	14.4%	35.5%	11.4%	0.0%	50.8%
East-EU	0.73	6.8%	31.7%	3.5%	0.0%	36.8%
EU	***2.49***	***11.2%***	***30.9%***	***7.9%***	***0.0%***	***41.7%***

3.2.7 Relative Competitiveness Index

Recall that relative competitiveness answers the question: are the product prices in a certain region competitive with the product prices of imported products from foreign competitors? A competitiveness indicator smaller than one indicate that prices of competitor regions are higher than the basic price in the own region, and vice versa for a competitiveness indicator larger than one. The competitive position of a region thus improves when the relative competitiveness indicator *decreases*. The formulation of the competitiveness index can be found in Annex A.1.

The position of EU regions become worse in terms of relative competitiveness. That is, prices of products sold by the EU are expected to be higher than prices of products of surrounding regions.

Developed regions are likely to have a higher relative competitiveness level compared to developing regions. The position of most EU regions becomes worse in terms of relative competitiveness. That is, prices in EU regions rise compared to regions outside Europe. It should be taken into account that the relative competitiveness indicator is a *relative* parameter. That is, when Asia and pacific, and America (that includes Latin-America) region might be better off under the 'Circular Industries' scenario, other regions are worse off, like the Middle-East and EU-regions. That way, by definition there are always relative 'winners' and relative 'losers' in the use of this indicator.

Table 37 shows relative competitiveness. In the baseline, the regions North-EU, South-EU and West-EU become have a relative worsened competitiveness level with respect to the base year in 2011. The competitiveness level of region East-EU improves slightly with respect to 2011 (that is, the relative competitive level of East-EU is smaller than one in 2030 for the baseline). The scenarios cause the relative competitiveness to become slightly worse in EU-regions.

For 'Circular Industries', the most important reason why the competitive position of EU regions becomes worst are the energy efficiency measures and measures that imply to reuse materials. These measures raise prices in a couple of industries that are relatively large compared to total

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economy and thereby also as export product. For example, products of industry iREBA (banking and real estate) are expected to increase only a little due to the measures in this scenario, however have a big influence on the relative competitiveness indicator.

For 'Closing the Loop', the ban on export of waste and keeping reprocessing production processes within the EU even has a negative effect on the competitive position of the EU. This can be explained as follows. The indicator 'relative competitiveness' is based on prices of products only. Higher prices of products sold by the EU result in a worsened competitive position according to this measure. However, banning export of waste and keeping reprocessing production processes in the EU has the economic effect that demand of product waste in the EU increases, because it is not allowed to go anywhere else. Higher demand increases the prices, and worsens the competitive position of Europe. However, this worsened competitive position is only artificial. Because it exists due to a ban. The EU does not even want other regions to make use of the EU waste product group.

Table 37 Relative competitiveness in the baseline, the four joined programmes and combined scenario in relation to the baseline for 2030.

	Baseline index (2030)	Circular Cities (2030)	Circular Industries (2030)	Closing the loop (2030)	Territory and Sea (2030)	Combined scenario SRIA (2030)
North-EU	1.031	0.2%	0.3%	0.2%	0.0%	0.9%
South-EU	1.048	0.6%	0.6%	0.5%	0.0%	1.5%
West-EU	1.055	0.4%	0.8%	0.4%	0.0%	1.3%
East-EU	0.999	0.2%	0.2%	0.5%	0.0%	0.8%
Europe not EU	0.997	-0.3%	-0.5%	-0.2%	0.0%	-0.9%
Asia and Pacific	0.946	-0.4%	-0.2%	0.1%	0.0%	-0.3%
Americas	0.981	-0.2%	-0.3%	-0.6%	0.0%	-0.9%
Africa and Middle East	1.025	0.0%	-0.4%	-0.5%	0.0%	-0.8%

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Conclusions and Recommendations

The objective of this report was to calculate the impacts of the SRIA on economy and environment. For this, the SRIA has been quantified and translated into modelling code.

In the development of the SRIA, four Joint Programs have been defined which shape the innovation fields into structured and strategic R&I programs. For this ex-ante impact assessment, 5 future scenarios and one baseline have been defined. The five scenarios correspond to the four joint programs, and one scenario that combines all joint programs of the SRIA. The scenarios are compared with a business-as-usual scenario until 2030.

Given the results in this report, we can answer the following question: "are the actions described in the SRIA sufficient to decouple economic growth from raw material extraction?" This question can only be answered under the assumption that the measures implemented in macro-economic model EXIOMOD sufficiently represent the Research and Innovation actions described in the SRIA. Actually, it is better to answer the question "are the measures implemented in the macro-economic model sufficient to demonstrate decoupling of economic growth from raw material extraction?"

Results of the ex-ante impact assessment show that the actions in the SRIA have a positive impact on gross domestic product (GDP). The increase in GDP is for a large part due to the actions that belong to 'Circular Industries'. This increase is mostly due to measures that cause efficiencies in the industries. In line with the growth in GDP, there is also some job creation. More importantly, jobs are expected to shift among the industries over the next ten years. Some sectors diminish in size and are therefore expected to lose jobs and other are expected to grow and generate more employment. Examples are a shifts of jobs from raw material producing industries to secondary material producing industries, and from fossil fuel industries to renewable energy industries.

Greenhouse gas (GHG) emissions are expected to reduce due to the energy efficiency measures and shift towards renewable energy. We find that greenhouse gas emissions are about 30% lower in 2030 in the scenario where all joint program actions are implemented compared to the baseline. The European Commission set a GHG emission reduction target of 40% in 2030 compared to 1990 levels. In September 2020, it was proposed to raise this reduction target even further, to 55% decrease with respect to 1990 levels. In comparison to these targets, according to our analysis a reduction of 49% is seen in the scenario which combines all joint programs.

The actions in the Joint Programs are expected to result in a shift from raw material use to secondary material use. Especially the extraction of non-metallic minerals and metals are expected to decrease, replaced by an increasing demand for secondary non-metallic minerals and metals. This is due to the actions that assume industries should reduce the input of primary raw materials in production processes and replace this input by secondary materials.

Note that all results are generated under the assumption that GDP is growing for the next ten years. An increase in GDP implies an increase in material use. The aim to improve welfare over the years restrains extensive reduction in material use. Despite that, Extracted Resource Productivity is still improving under the actions described by the SRIA.

It was found that another limiting factor in reduction of primary raw materials is the availability of waste. An every growing economy, both in population as in economic growth, goes together with an increase in demand for materials. Products sold in the past, are under the same welfare assumptions not sufficient to cover material demand in the future.

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This report shows the expected impact of various indicators of actions described in the SRIA on economy and environment. We recommend the European Commission to continue and improve data collection on a variety of indicators that monitor Circular Economy targets. This enables us track our progress in moving towards a circular economy.

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Annex A Additional information on methodology and data

A.1 Equations relative competitiveness

The relative competitiveness indicator shows the impact of the policy scenarios on the competitive position of a region, as explained in Section 3.1.7. Equations behind this indicator are given in this annex.

The relative competitiveness indicator is specified as follows:

$$PXI_{r,y} = \sum_{prd} \frac{P_{r,prd,y}}{PCXI_{r,prd,y}} \cdot \frac{export_{r,prd,y}}{\sum_{prdd} export_{r,prdd,y}};$$

where

$$PCXI_{r,prd,y} = \sum_{rr \neq r} \frac{trade_{r,prd,rr,y}}{export_{r,prd,y}} \cdot PCXIK_{r,prd,rr,y};$$

is the weighted average export price of product prd from region r to any region in the world.

$$PCXIK_{rr,prd,r,y} = \sum_{rrr \neq r} \frac{\frac{trade_{rrr,prd,rr,y}}{import_{prd,rr,y}}}{1 - \frac{trade_{rrr,prd,rr,y}}{import_{prd,rr,y}}} \cdot P_{rrr,prd,y}$$

is the weighted average of prices of all regions in the world to region r, i.e. an average 'export price'. Trade parameter $trade_{r,prd,rr,y}$ gives the trade of product prd between region r and region rr in year y. Taking the sum over the import regions rr gives $export_{r,prd,y}$, and taking the sum over the export regions r give $import_{prd,rr,y}$. Basic product prices in region r are given by $P_{r,prd,y}$.

A.2 Extra information on material use in EXIOBASE

This report uses EXIOBASE 3.0 with corresponding physical extensions. The physical extensions give information on material use for the 163 sectors in EXIOBASE. That is, the physical extensions provide material use in 'production definition' (see the section with 'Definitions and acronyms' for more information on this definition). Material use is broadly divided in five categories. This annex further specifies the materials that are included int these five categories: biomass, metal ores, non-metallic minerals, wood and fossil fuels.

Table 38 Definition of materials in EXIOBASE 3.0

Wood	Metal ores	Non-Metallic Minerals	Fossil Fuels
Coniferous wood - Industrial roundwood	Uranium and thorium ores	Other minerals	Anthracite
Coniferous wood - Wood fuel	Iron ores	Limestone, gypsum, chalk, dolomite	Coking coal
Non-coniferous wood - Industrial roundwood	Copper ores	Slate	Other bituminous coal
Non-coniferous wood - Wood fuel	Nickel ores	Building stones	Sub-bituminous coal
Raw materials other than wood	Bauxite and aluminium ores	Clays and kaolin	Lignite/brown coal
Kapok Fruit	Gold ores	Gravel and sand	Peat
Natural Gums	PGM ores	Salt	Crude oil
	Silver ores	Chemical and fertilizer minerals	Natural gas

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	Lead ores		Natural gas liquids
	Tin ores		Oil shale and oil sands
	Zinc ores		Other hydrocarbons
	Other non-ferrous metal ores		

Biomass				
Rice	Spinach	Roots and Tubers, nes	Linseed	Pyrethrum, Dried Flowers
Wheat	Tomatoes	Taro	Melonseed	Tea
Barley	Vegetables Fresh nec	Yautia	Mustard Seed	Spices nec
Buckwheat	Apples	Bambara beans	Poppy Seed	Cocoa Beans
Canary Seed	Apricots	Beans, dry	Rapeseed	Mate
Maize	Avocados	Beans, green	Safflower Seed	Tobacco Leaves
Millet	Blueberries	Broad beans, horse beans, dry	Sesame Seed	Natural Rubber
Mixed Grain	Carobs	Chick peas	Soybeans	Cinnamon
Oats	Cherries	Cow peas, dry	Sunflower Seed	Cloves
Rye	Currants	Peas, dry	Oilseeds nec	Ginger
Sorghum	Dates	Pigeon peas	Oil Palm Fruit	Nutmeg, mace and cardamoms
Triticale	Figs	String beans	Castor oil seed	Vanilla
Cereals nec	Gooseberries	Coconuts	Karite Nuts	Pepper
Fonio	Grapefruit and Pomelos	Okra	Tung Nuts	Chillies and peppers, dry
Quinoa	Grapes	Onions	Jojoba Seeds	Tea nes
Potatoes	Kiwi Fruit	Onions, dry	Tallowtree Seeds	Honey
Sweet Potatoes	Lemons and Limes	Other melons	Cottonseed	Beeswax
Yams	Oranges	Watermelons	Sugar Beets	Kapokseed in Shell
Lentils	Peaches and Nectarines	Bananas	Sugar Cane	Straw
Lupins	Pears	Cashewapple	Sugar Crops nes	Feed
Vetches	Persimmons	Cranberries	Cotton Lint	Alfalfa for Forage and Silage
Pulses nec	Pineapples	Fruit Fresh Nes	Flax Fibre and Tow	Beets for Fodder
Olives	Plums	Fruit, tropical fresh nes	Hemp Fibre and Tow	Cabbage for Fodder
Artichokes	Quinces	Mangoes, mangosteens, guavas	Abaca	Carrots for Fodder
Asparagus	Raspberries	Papayas	Agave Fibres nes	Clover for Forage and Silage
Cabbages	Sour Cherries	Plantains	Coir	Maize for Forage and Silage
Carrots	Strawberries	Arecanuts	Fibre Crops nes	Other grasses
Cauliflower	Tang. Mand Clement. Satsma	Brazil nuts, with shell	Ramie	Rye Grass, Forage and Silage
Chillies and peppers, green	Berries nec	Cashew nuts, with shell	Sisal	Sorghum for Forage and Silage
Cucumbers and Gherkins	Citrus Fruit nec	Kolanuts	Kapok Fibre	Swedes for Fodder
Eggplants	Stone Fruit nec,	Nuts, nes	Jute and Jute-like Fibres	Turnips for Fodder
Garlic	Almonds	Leguminous vegetables, nes	Other Bastfibres	Vegetables and Roots, Fodder
Leeks and other Alliac. Veg.	Chestnuts	Maize, green	Anise, Badian, Fennel	Forage Products nec
Lettuce	Hazelnuts	Pome fruit, nes	Chicory Roots	Grasses nec for Forage and Silage
Mushrooms	Pistachios	Cassava leaves	Coffee, Green	Leguminous nec for forage and Silage
Peas, Green	Walnuts	Groundnuts in Shell	Hops	Green Oilseeds for Fodder
Pumpkins, Squash, Gourds	Cassava	Hempseed	Peppermint	

A.3 Product and industry aggregation

For the quantification of the SRIA, the variables in the database underlying to the macro-economic model EXIOMOD have been aggregated for products, industries and regions. In this annex it is shown what the mapping of the 163 industries of EXIOBASE to the 36 products for the quantification of the SRIA looks like (see Table 39). The mapping of products look more or less similar.

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Table 39 Mapping of 163 industries defined by EXIOBASE 3.0 to 36 industries used for the quantification of the SRIA.

CICERONE industry definition	Mapping to industries in EXIOBASE			
iPLNT	Cultivation of paddy rice	Cultivation of cereal grains nec	Cultivation of oil seeds	Cultivation of plant-based fibers
	Cultivation of wheat	Cultivation of vegetables, fruit, nuts	Cultivation of sugar cane, sugar beet	Cultivation of crops nec
iANIM	Cattle farming	Meat animals nec	Raw milk	Manure treatment (conventional), storage and land application
	Pigs farming	Animal products nec	Wool, silk-worm cocoons	Manure treatment (biogas), storage and land application
	Poultry farming	-	-	-
iFORE	Forestry, logging and related service activities (02)			
iFISH	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05)			
iFOSM	Mining of coal and lignite; extraction of peat (10)	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying	Extraction of natural gas and services related to natural gas extraction, excluding surveying	Extraction, liquefaction, and regasification of other petroleum and gaseous materials
iOTHM	Mining of uranium and thorium ores (12)	Mining of nickel ores and concentrates	Mining of lead, zinc and tin ores and concentrates	Quarrying of sand and clay
	Mining of iron ores	Mining of aluminium ores and concentrates	Mining of other non-ferrous metal ores and concentrates	Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.
	Mining of copper ores and concentrates	Mining of precious metal ores and concentrates	Quarrying of stone	-
iFBTO	Processing of meat cattle	Production of meat products nec	Processed rice	Manufacture of beverages
	Processing of meat pigs	Processing vegetable oils and fats	Sugar refining	Manufacture of fish products
	Processing of meat poultry	Processing of dairy products	Processing of Food products nec	Manufacture of tobacco products (16)
iTXWO	Manufacture of textiles (17)	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)	Pulp	Publishing, printing and reproduction of recorded media (22)
	Manufacture of wearing apparel; dressing and dyeing of fur (18)	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20)	Paper	-
iCOKE	Manufacture of coke oven products			
iREFN	Petroleum Refinery	Processing of nuclear fuel	-	-
iCHEM	Plastics, basic	N-fertiliser	P- and other fertiliser	Chemicals nec
iRUBP	Manufacture of rubber and plastic products (25)			
iNMMP	Manufacture of glass and glass products	Manufacture of bricks, tiles and construction products, in baked clay	Manufacture of cement, lime and plaster	Manufacture of other non-metallic mineral products n.e.c.
	Manufacture of ceramic goods	-	-	-
iMETP	Manufacture of basic iron and steel and of ferro-alloys and first products thereof	Aluminium production	Copper production	Casting of metals
	Precious metals production	Lead, zinc and tin production	Other non-ferrous metal production	Manufacture of fabricated metal products, except machinery and equipment (28)
iMACH	Manufacture of machinery and equipment n.e.c. (29)	-	-	-
iELEC	Manufacture of office machinery and computers (30)	Manufacture of electrical machinery and apparatus n.e.c. (31)	Manufacture of radio, television and	-

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			communication equipment and apparatus (32)	
iMACH	Manufacture of medical, precision and optical instruments, watches and clocks (33)	Manufacture of motor vehicles, trailers and semi-trailers (34)	Manufacture of other transport equipment (35)	Manufacture of furniture; manufacturing n.e.c. (36)
iRECY	Recycling of waste and scrap	Recycling of bottles by direct reuse	-	-
iELCF	Production of electricity by coal	Production of electricity by gas	Production of electricity by nuclear	Production of electricity by petroleum and other oil derivatives
iELCG	Production of electricity by hydro	Production of electricity by biomass and waste	Production of electricity by solar thermal	Production of electricity by Geothermal
	Production of electricity by wind	Production of electricity by solar photovoltaic	Production of electricity by tide, wave, ocean	Production of electricity nec
iTRDI	Transmission of electricity	Distribution and trade of electricity	Manufacture of gas; distribution of gaseous fuels through mains	-
iHWAT	Steam and hot water supply	-	-	-
iWATR	Collection, purification and distribution of water (41)			
iCONS	Construction (45)			
iTRAD	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessoiries	Retail sale of automotive fuel	Wholesale trade and commission trade, except of motor vehicles and motorcycles (51)	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52)
iHORE	Hotels and restaurants (55)			
iTRAN_other	Transport via railways	Transport via pipelines	Air transport (62)	Supporting and auxiliary transport activities; activities of travel agencies (63)
	Other land transport	-	-	-
iTRAN_water	Sea and coastal water transport	Inland water transport	-	-
iPUBO	Post and telecommunications (64)	Financial intermediation, except insurance and pension funding (65)	Insurance and pension funding, except compulsory social security (66)	Activities auxiliary to financial intermediation (67)
iREBA	Real estate activities (70)	Computer and related activities (72)	Research and development (73)	Other business activities (74)
iRENT	Renting of machinery and equipment without operator and of personal and household goods (71)			
iPUBO	Public administration and defence; compulsory social security (75)	Health and social work (85)	Recreational, cultural and sporting activities (92)	Private households with employed persons (95)
	Education (80)	Activities of membership organisation n.e.c. (91)	Other service activities (93)	-
iWAST	Incineration of waste: Food	Incineration of waste: Wood	Composting of food waste, incl. land application	Landfill of waste: Paper
	Incineration of waste: Paper	Incineration of waste: Oil/Hazardous waste	Composting of paper and wood, incl. land application	Landfill of waste: Plastic
	Incineration of waste: Plastic	Biogasification of food waste, incl. land application	Waste water treatment, food	Landfill of waste: Inert/metal/hazardous
	Incineration of waste: Metals and Inert materials	Biogasification of paper, incl. land application	Waste water treatment, other	Landfill of waste: Textiles
	Incineration of waste: Textiles	Biogasification of sewage slugde, incl. land application	Landfill of waste: Food	Landfill of waste: Wood
iREPR_TXWO	Re-processing of secondary wood material into new wood material	Re-processing of secondary paper into new pulp	-	-
iREPR_RUBP	Re-processing of secondary plastic into new plastic	-	-	-
iREPR_NMMP	Re-processing of secondary glass into new glass	Re-processing of ash into clinker	-	-

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iREPR_METP	Re-processing of secondary steel into new steel	Re-processing of secondary aluminium into new aluminium	Re-processing of secondary copper into new copper	Re-processing of secondary other non-ferrous metals into new other non-ferrous metals
	Re-processing of secondary preciuos metals into new preciuos metals	Re-processing of secondary lead into new lead	-	-
iREPR_CONS	Re-processing of secondary construction material into aggregates	-	-	-

A.4 Secondary material use

Secondary material use was originally not part of database EXIOBASE. It was constructed from four data sources: (1) Total material use in production processes per country and material type from Eurostat. (2) circular material use rate per county from Eurostat (3) circular material use rate per material type from Eurostat (4) industry shares for DEU material types from EXIOBASE.

This annex gives the secondary material use per region and material type based on the first three sources.

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Table 40 Secondary material use per region in EU27 and secondary material type.

Secondary material use (kt)	Reprocessed Biomass	Reprossessed Metal ores (gross ores)	Reprocessed Non-metallic minerals	Reprocessed Fossil energy materials/carriers
Belgium	699	2,234	12,975	53
Bulgaria	67	215	1,248	5
Czechia	467	761	4,777	37
Denmark	263	841	4,887	20
Germany (until 1990 former territory of the FRG)	3,779	12,071	70,119	287
Estonia	162	517	3,001	12
Ireland	27	87	506	2
Greece	77	247	1,433	6
Spain	1,627	5,197	30,189	124
France	4,952	15,821	91,903	376
Croatia	82	24	622	2
Italy	2,760	8,815	51,208	210
Cyprus	16	52	300	1
Latvia	16	50	293	1
Lithuania	43	138	802	3
Luxembourg	117	374	2,170	9
Hungary	564	231	2,430	14
Malta	5	17	97	0
Netherlands	1,312	4,191	24,347	100
Austria	357	1,140	6,622	27
Poland	6,497	6,609	47,171	119
Portugal	112	356	2,070	8
Romania	290	926	5,381	22
Slovenia	73	232	1,350	6
Slovakia	385	322	1,744	8
Finland	1,114	3,559	20,673	85
Sweden	614	1,960	11,386	47

For connecting the secondary materials to the industries, we make two separate assumptions. For secondary non-metallic minerals it is assumed that all are produced in the reprocessed non-metallic mineral industry (iREPR_NMMP), and all secondary metals are produced in the reprocessed metal industry (iREPR_METP). For secondary biomass and secondary fossil energy materials/ carriers we use the industry shares for Domestic Extraction Used for Biomass and Fossil Fuels respectively from EXIOBASE. Therefore, similar to our definition for raw material use, secondary material use in fact refers to 'extracted' or 'produced' materials within the EU.

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A.5 Translation targets from literature to shock into the model

This section might include references to product and industry codes that are used in EXIOMOD. Explanation of these codes can be found in Section A.2.

A.5.1 Circular Cities

Literature	Shock applied to the model
(European Commission, 2019) "- In 2020 70% C&D waste "shall be prepared for re-use, recycled or undergo other material recovery" - In 2030 we put the same goal to 90% (some countries already had this in 2011, although that was including backfilling)"	High material recovery rates for the EU (https://ec.europa.eu/eurostat/databrowser/view/cei_wm040/default/table?lang=en). However, most is backfilling (https://ec.europa.eu/environment/waste/studies/pdf/CDW%20Statistics%202011.pdf). We assume 0% recycling in 2011 and set a goal of 30% for 2030. iCONS will use less pTXWO, pRUBP, pNMMP and pMETP and instead use more pREPR_CONS.
(European Commission, 2018) "Member States shall take the necessary measures designed to achieve the following targets: - by 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55 % by weight; - by 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60 % by weight; - by 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65 % by weight."	Using initial data for waste generated and recycled (https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasmun&lang=en) and the recycling targets, projections were made until 2030. Using waste composition (https://www.researchgate.net/figure/Average-MSW-composition-in-EU_tbl1_225979972), recycling rates and prices (https://ars.els-cdn.com/content/image/1-s2.0-S0377221718309354-mmc1.pdf) it is determined how much of secondary materials certain industries will use instead of raw materials. iTXWO will use pREPR_TXWO instead of pTXWO, iRUBP will use pREPR_RUBP instead of pCHEM, iMETP will use pREPR_METP instead of pMETP, and iCONS will use pREPR_NMMP and pREPR_CONS instead of pNMMP.
Signatories of Dutch plastic pact (e.g. plastic producers and food companies) (Geijer, 2019) 20% fewer kilos of plastic packaging per kilogram of product, in 2025 (compared to base year 2017).	This goal is extended to 2030, a reduction of 30%. iFBTO will use 20% less pRUBP in 2025 and 30% less RUBP in 2030 compared to 2011.
-	For more local food production a quantified goal was not found. An increase of 10% in 2030 w.r.t. 2011 is used. Phi_h_imp is increased and phi_h_dom decreases.
(Greenpeace, 2020) "Meat consumption in the European Union should drop by 71% by 2030, and by 81% by 2050, to tackle farming's contribution to climate breakdown, according to new analysis by Greenpeace. This would mean an average of no more than 460 grams of all types of meat leaving the slaughterhouse per person per week by 2030, and 300 grams in 2050, down from the current EU average of 1.58 kilograms per person per week."	A decrease of 71% in 2030 w.r.t. 2011 is modelled. The household consumption of pANIM decrease with this factor. The decrease is compensated with an increase of pPLNT. Similarly, the ioc of iFBTO is altered, 71% less pANIM, which is replaced by pPLNT.
(Commission, 2020a) "The EU and the EU countries are committed to meeting the Sustainable Development Goal 12.3 target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains."	The EXIOMOD food products are defined by pPLNT, pANIM, pFISH, pFBTO. EXIOBASE gives information on the million euros that regions spend on these products. This information is combined with information current cost of food waste (143 billion in the EU in total divided over households and industries) (https://ec.europa.eu/food/safety/food_waste_en). For each region, the share of money spend on food that is wasted with respect to total money spend on food is calculated. Industries (iPLNT, iANIM, iFISH, iFBTO, iHORE) and households reduce spendings on food products towards 2030. Production costs of industries decrease, however households spend the money saved proportionally on other products.
(Kirhensteine, 2016) "A previous study conducted by BIO in 2012 concluded that EU policy on certification to promote rainwater harvesting and reuse in buildings could achieve a 5% reduction in potable	Households will use water more efficiently. This is modelled by decreasing household consumption for the product pWATR. A total decrease of water usage by households of 4% in 2030 w.r.t. 2011 is modelled. Similarly, it is assumed that iPLNT will use less pWATR. For the different regions different

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water use by 2050 but would be applicable only for major renovation or new buildings."	goals are used, SEU a decrease of 12%, EEU a decrease of 42%, WEU no decrease and NEU a decrease of 25%. The ioc is adjusted accordingly.

A.5.2 Circular Industries

Literature	Shock applied to the model
(European Commission, 2018c) *"Bio-based share of all chemical sales will rise to 22% by 2020; in the bio-based industries one million new jobs could be created by 2030, according to industry estimates"* (Biddy, 2016) "Recent analysis projects the market share of bio-based chemicals in the global chemical industry will increase from 2% in 2008 to 22% in 2025, and the market potential for bio-based chemicals will be $19.7 billion in 2016"	The bio-based share of chemical input products in the chemical industry is equal to 3.4% in 2019 (https://ec.europa.eu/jrc/en/publication/insights-european-market-bio-based-chemicals) and assumed 22% in 2030. With no other information, it is assumed that the share in the base year of EXIOMOD is equal to the share in 2019, i.e. 3.4%. Based on these information yearly growth rates are generated for 2011-2030. Bio-based input products include pFISH, pANIM, pFORE, pPLNT. The input coefficients are multiplied with the yearly growth rates.
(United Nations, 2015) "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses"	*We do not model this in this scenario. We assume it is part of 'Circular Cities'.*
(Pardo, 2018) "The EU should follow the Dutch lead and work towards a 50% reduction in primary raw material consumption by 2050" (The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs , 2016) "The ambition of the Cabinet is to realise, together with a variety of stakeholders, an (interim) objective of a 50% reduction in the use of primary raw materials (minerals, fossil and metals) by 2030."	Other targets implemented for this Joint Program (and other Joint Programs) reduce the use of virgin materials in specific industries and increase the use of reprocessed materials. For this scenario we assume that each European industry at least reduces the input of primary raw materials by 50%. If the combination of other targets already result in a decrease of 50% or more for a certain industry in the EU, then this scenario will not reduce that target even more. Assumed raw material input products for this scenario are (pTXWO, pCHEM, pOTHM). Assumed reprocessed material input product groups are pREPR_TXWO, pREPR_NMMP, pREPR_METP, pREPR_RUBP.
(European Commission, 2020b) "As part of this legislative initiative, and, where appropriate, through complementary legislative proposals, the Commission will consider establishing sustainability principles and other appropriate ways to regulate the following aspects: • improving product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products, and increasing their energy and resource efficiency; • increasing recycled content in products, while ensuring their performance and safety; • enabling remanufacturing and high-quality recycling; • restricting single-use and countering premature obsolescence; • introducing a ban on the destruction of unsold durable goods; • incentivising product-as-a-service or other models where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycle"	Since no quantified goals are defined, we assume the following goals here: Reuse - Assume that the sectors iELEC and iMACH use 25% less of materials pTXWO, pMETP, pNMMP, pRUBP. Because products can be reused. - Assume that paper and paper products are used less in service industries (decrease of 30%), because paper products are becoming unnecessary due to digitalization. Lease/ product as a service - All industries demand less products from pELEC and pMACH (25% less). Because these electronics and machinery products can also be leased rather than sold. - All industries demand more products from pRENT (leasing industry). Take 25% of what an industry initially spend on products pELEC and PMACH.
(European Commission, 2018b) "(f) no later than 31 December 2025 a minimum of 65 % by weight of all packaging waste will be recycled; (g) no later than 31 December 2025 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: (i) 50 % of plastic; (ii) 25 % of wood; (iii) 70 % of ferrous metals; (iv) 50 % of aluminium; (v) 70 % of glass; (vi) 75 % of paper and cardboard;	These recycling targets are used in the model to change the percentage of virgin material input to reprocessed material input. Historic recycling rates are combined with recycling targets for 2025 and 2030. Interpolation gives a trajectory for 2011-2030 for different materials. Historic waste collection data is combined with assumptions on future waste collection (based on gpd and population growth projections). This gives trajectories for million tons of waste collected in the EU.

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(h) no later than 31 December 2030 a minimum of 70 % by weight of all packaging waste will be recycled; (i) no later than 31 December 2030 the following minimum targets by weight for recycling will be met regarding the following specific materials contained in packaging waste: (i) 55 % of plastic; (ii) 30 % of wood; (iii) 80 % of ferrous metals; (iv) 60 % of aluminium; (v) 75 % of glass; (vi) 85 % of paper and cardboard."	Combining waste collection data with recycling rates gives historic and forecasted recycled materials that can be used as input in the production processes again. The actual yield rate of collected material for recycling is also taken into account (https://ars.els-cdn.com/content/image/1-s2.0-S0377221718309354-mmc1.pdf). Under the assumption that all recycled material goes back into the production process, the use of virgin materials decrease and the use of reprocessed materials increase according to calculations above. Industry iTXWO reduces virgin material product pTXWO, and increases use of reprocessed product pREPR_TXWO. Industry iRUBP reduces virgin material product 'pCHEM' and increases use of reprocessed product pREPR_RUBP Industry iMETP reduces virgin material product pOTHM and increases use of reprocessed product pREPR_METP Industry iNMMP reduces virgin material product pOTHM and increases use of reprocessed product pREPR_NMMP
(European Commission Representation in Germany , 2019) "A minimum quota of 90 per cent for the separate collection of plastic bottles by 2029 (77 per cent by 2025) and the introduction of product design rules requiring the lids to be firmly attached to beverage bottles, as well as the target of 25 per cent recycled plastic in PET bottles from 2025 and 30 per cent in all plastic bottles from 2030."	See above. This is recycling of pRUBP product group.
(European Commission, 2020c) "Key targets for 2030: • At least 32% share for renewable energy At least 32.5% improvement in energy efficiency"	32% share of renewables The model distinguishes two industries that are mainly responsible for the production of electricity: iELCF and iELCG. iELCF is the industry that produce electricity (pELCT) by fossil fuels and nuclear sources, iELCG produces electricity pELCT by renewables. The supply table shares are defined by EXIOMOD and defined how much of a product is produced by which industry. Given that in 2030, 32% of all electricity should be produced by sector iELCG, supply table shares are changed between 2011-2030. 32.5% improvement in energy efficiency All industries in the EU (except for energy producing industries iREFN, iFOSM, iELCF, iELCG) use 32% less of energy products. The energy producing industries are excluded from this efficiency, because it is assumed that these industries do not change their production process, i.e. the same amount of energy products is used to give (another) energy product as output. These sectors have a very large demand for energy products, the assumption that also these sectors reduce energy consumption by 32.5 would imply large changes in the production process, which is not realistic.

A.5.3 Closing the loop

Literature	Shock applied to the model
(Pardo, 2018) "The EU should follow the Dutch lead and work towards a 50% reduction in primary raw material consumption by 2050" (Felipe, 2012) Figure 1 gives share of complex products per per product type (approximated numbers are taken).	Complex products require less raw material inputs. For each industry, the share of complex products produced needs to be defined. Complex product shares per product type are given in Figure 1 of (Felipe, 2012). The approximated share -read from the figure- are given in the table below :

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	Chemicals 80% Machinery/ electrical 70% Plastics/ Rubbers 70% Transportation 60% Metals 65% Miscallaneous 60% Stone/ Glass 50% Wood and Wood products 50% Mineral products 40% Animal and animal products 35% Foodstuffs 20% Vegetable products 15% Textiles 15% Raw Hides/ Skins/ etc 10% Footwear/ Headgear 10% The target of 50% reduction of raw materials in this scenario only holds for complex products. This implies that we replace the raw material inputs (pTXWO, pCHEM, pOTHM) of the following industries iCHEM, iELEC, iRUBP, iTRAN_other, iMETP, iNMMP, iTXWO, iANIM, iFBTO) by the input of reprocessed materials (iREPR_TXWO, iREPR_RUBP, iREPR_NMMP, iREPR_METP). Note that this target has to be replaced by the
(Circular Economy Action Plan , 2020) “In the light of these developments, and considering that illegal shipments of waste remain a source of concern, the Commission will take action with the aim to ensure that the **EU does not export** its waste challenges to third countries. Actions on product design, quality and safety of secondary materials and enhancing their markets will contribute to making “recycled in the EU” a benchmark for qualititative secondary materials.”	The European Commission intents not to export any waste to countries outside the EU. The model contains a parameter (phi_dom) that indicates the share of a product that is purchased by <u>domestic</u> industries of a certain region. For product group ‘pWAST’ this share should be equal to 1 n 2030 for all European industries that have demand for this product group. Also, European reprocessing industries should only use domestic product groups as input for their production processes, and share phi_dom is therefore also set to 1 for these product-industry-region combinations. Joint Program ‘Closing the loop’ also describes the decrease of virgin materials from output Europe. Without any quantitative target, we assume that the current input share of raw materials (pOTHM, pTXWO, pCHEM) fom outside Europe is halved by 2030.
(Kleemann, 2018) “Thus, even a theoretical recycling of demolition waste at a rate of 100% and its sole utilization in the building sector could only substitute for about 35% of primary raw material demand.”	Urban mining is part of the Joint Program ‘Closing the loop’. We assume that the maximum amount of available reprocessed material will in 2030 be used as in put in the production process. According to (Kleemann, 2018) this is equal to 35% of primary material demand. Therefore, we reduce the primary material demand and increase the reprocessed material demand in sector ‘iCONS’ until it reaches the ratio 65/35 in 2030.
(Smedley, 2020) “Globally, the world produces as much as 50 million tonnes of e-waste a year – the equivalent to 6,000 Eiffel Towers – and it is growing 3-4% annually.” “It is estimated that to produce a year’s worth of new equipment for Europe would require 2.9Mt of plastic, 270,000 tonnes of copper, 3,500 tonnes of cobalt and 26 tonnes of gold.” “Europe is the world’s second highest producer of e-waste, throwing away around 12.3Mt of electronic equipment and batteries a year. Hidden inside is 330,000 tonnes of copper and 31 tonnes of gold.”	Urban mining is part of the Joint Program ‘Closing the loop’. We assume that the sector that produces electronical products (iELEC) can in 2030 make use of e-waste as input in the production process. Based on numbers from (Smedley, 2020) it seems that Europe could become 100% dependent on the waste flow (12.3 Mton of electronic equipment waste versus 2.9+0.27+ 0.035 demand for new equipment). We limit the target on use of electronic waste a little bit to 80% use of reprocessed materials as input (pTXWO, pOTHM, pCHEM) in the electronic products industry (iELEC) and 20% coming from raw materials (pREPR_TXWO, pREPR_METP, pREPR_NMMP, pREPR_RUBP) in 2030.
(European Commission, 2020d) “Budget for the EU on Research infrastructures (including e-infrastructure) (Ensuring access to world-class facilities) 2488 million euro ».	Subprogram C1 of joint Program ‘Closing the loop’ aims to place a focus ‘*on the development of data systems and tools to support the circularity and provide tools to industries to better manage their supply chains*.’ In this scenario we assume that the Government invests in development of data systems (part of productgroup ‘pREBA’). On the

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	other hand, all industries become slightly more efficient by spending less money on product group 'pREBA'.

A.5.4 Territory and Sea

Literature	Shock applied to the model
(Mofor, 2014) "The industry itself has set targets to reduce carbon dioxide emissions by 20% by 2020 and 50% by 2050. Ship operators, therefore, need to consider cleaner fuel and power options, including the use of renewables, to meet these targets."	The goals are modelled as a 20% reduction in 2020 and a 30% reduction in 2030 w.r.t. 2011. Three products are considered, pFOSM, pREFN and pELCT. The use of pFOSM and pREFN by iTRAN_water will decrease, which will use pELCT instead.
(Pal, 2016) "In industry or local seafood shops, processing of seafood generates a huge quantity (50–80%) of nonedible by-products, which are discarded as waste or underutilised in several parts of the world." (European Commission, 2018) "Reduction of waste disposal by 20% in the selected value chain, as compared to the current situation."	According to the literature, we assume that in 2011 50% of seafood is wasted and 50% is used. A 20% decrease of waste in 2030 results in 40% wasted and 60% used. Effectively, this means that iFISH becomes more efficient.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

Annex B Additional result tables

This annex presents more detail to the findings in the result section of the report. Most of these results are presented on EU-27 level. Results like price indices should not be averaged over the regions and are therefore presented four the four EU-regions separately.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1 Additional result tables: Circular Cities

B.1.1 Output

Table 41 Industry output in million euro for EU-27 in 2030. Industry definition can be found in Table 28

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Circular Cities' scenario*	*Percentage change with respect to the baseline ('Circular Cities' Scenario)*
iPLNT	242,368	337,287	39.2%
iANIM	191,304	84,058	-56.1%
iFORE	39,992	37,931	-5.2%
iFISH	14,459	18,744	29.6%
iFOSM	75,915	74,334	-2.1%
iOTHM	279,950	244,935	-12.5%
iFBTO	993,075	897,655	-9.6%
iTXWO	890,984	792,027	-11.1%
iCOKE	7,379	7,255	-1.7%
iREFN	373,483	370,699	-0.7%
iCHEM	540,838	522,013	-3.5%
iRUBP	342,870	325,990	-4.9%
iNMMP	242,179	201,973	-16.6%
iMETP	959,590	924,237	-3.7%
iELEC	759,602	718,178	-5.5%
iMACH	2,483,955	2,291,285	-7.8%
iELCF	143,312	144,204	0.6%
iELCG	89,431	88,383	-1.2%
iTRDI	407,391	405,146	-0.6%
iHWAT	21,612	21,672	0.3%
iWATR	61,785	60,809	-1.6%
iCONS	2,253,028	2,267,193	0.6%
iTRAD	1,658,665	1,637,656	-1.3%
iHORE	902,568	951,614	5.4%
iTRAN_water	123,939	121,322	-2.1%
iTRAN_other	1,771,849	1,745,445	-1.5%
iREBA	4,255,127	4,265,769	0.3%
iRENT	289,377	436,382	50.8%
iPUBO	6,976,864	7,008,131	0.4%
iWAST	226,988	224,805	-1.0%
iRECY	63,628	62,951	-1.1%
iREPR_TXWO	99,172	110,308	11.2%
iREPR_RUBP	86,751	100,238	15.5%
iREPR_NMMP	45,977	51,288	11.6%
iREPR_METP	157,093	155,903	-0.8%
iREPR_CONS	7,428	76,331	927.6%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.2 Employment

Table 42 Employment in 1000 p for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total employment in 1000 p in 2030 in the baseline*	*Total employment in 1000 p in 2030 in 'Circular Cities' scenario*	*Percentage change with respect to the baseline ('Circular Cities' Scenario)*
iPLNT	5,870	8,218	40.0%
iANIM	2,783	1,296	-53.4%
iFORE	1,284	1,212	-5.6%
iFISH	359	507	41.0%
iFOSM	161	159	-1.1%
iOTHM	597	533	-10.8%
iFBTO	4,029	3,614	-10.3%
iTXWO	5,049	4,480	-11.3%
iCOKE	4	4	0.8%
iREFN	241	241	0.0%
iCHEM	2,023	1,963	-3.0%
iRUBP	1,231	1,175	-4.6%
iNMMP	1,360	1,147	-15.6%
iMETP	4,553	4,397	-3.4%
iELEC	2,371	2,246	-5.3%
iMACH	10,090	9,337	-7.5%
iELCF	348	350	0.4%
iELCG	160	160	0.2%
iTRDI	844	850	0.7%
iHWAT	49	50	1.3%
iWATR	302	300	-0.6%
iCONS	15,582	15,752	1.1%
iTRAD	30,208	29,946	-0.9%
iHORE	9,727	10,388	6.8%
iTRAN_water	306	303	-1.1%
iTRAN_other	9,592	9,506	-0.9%
iREBA	26,552	26,846	1.1%
iRENT	620	978	57.7%
iPUBO	70,483	71,125	0.9%
iWAST	1,289	1,282	-0.5%
iRECY	200	198	-1.2%
iREPR_TXWO	610	699	14.6%
iREPR_RUBP	203	248	22.1%
iREPR_NMMP	231	264	14.4%
iREPR_METP	423	423	0.1%
iREPR_CONS	73	648	793.1%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.3 Price indices

Table 43 Price indices for 4 EU-regions in 2030. Index equals 1 for all regions in 2011. CC refers to 'Circular Cities' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*NEU*		*SEU*		*WEU*		*EEU*	
	BAU	CC	BAU	CC	BAU	CC	BAU	CC
pPLNT	1.065	1.069	1.083	1.097	1.086	1.096	1.030	1.037
pANIM	1.063	1.067	1.071	1.080	1.081	1.090	1.031	1.037
pFORE	1.084	1.089	1.082	1.095	1.069	1.077	1.017	1.024
pFISH	1.055	1.058	1.067	1.076	1.050	1.055	1.020	1.026
pFOSM	1.102	1.107	1.057	1.065	1.074	1.082	1.003	1.010
pOTHM	1.096	1.100	1.059	1.067	1.049	1.053	1.029	1.037
pFBTO	1.051	1.054	1.064	1.065	1.069	1.068	1.023	1.023
pTXWO	1.051	1.055	1.058	1.064	1.065	1.071	1.010	1.014
pCOKE	1.077	1.080	1.040	1.044	1.039	1.043	1.018	1.023
pREFN	1.068	1.071	1.072	1.075	1.072	1.076	1.014	1.019
pCHEM	1.070	1.075	1.060	1.068	1.070	1.077	1.017	1.023
pRUBP	1.053	1.051	1.057	1.062	1.065	1.071	1.014	1.016
pNMMP	1.055	1.051	1.060	1.067	1.060	1.066	1.017	1.021
pMETP	1.050	1.053	1.053	1.059	1.055	1.060	1.017	1.023
pELEC	1.044	1.048	1.057	1.064	1.057	1.062	1.014	1.019
pMACH	1.045	1.049	1.055	1.062	1.057	1.063	1.016	1.022
pELCT	1.062	1.065	1.074	1.085	1.083	1.093	1.026	1.032
pTRDI	1.062	1.066	1.067	1.078	1.076	1.085	1.029	1.035
pHWAT	1.056	1.059	1.068	1.077	1.068	1.076	1.022	1.027
pWATR	1.053	1.057	1.073	1.084	1.084	1.094	1.011	1.017
pCONS	1.043	1.044	1.062	1.069	1.063	1.069	1.021	1.026
pTRAD	1.049	1.054	1.062	1.071	1.067	1.073	1.016	1.023
pHORE	1.040	1.023	1.074	1.070	1.071	1.052	1.006	0.972
pTRAN_water	1.036	1.040	1.073	1.084	1.068	1.076	1.003	1.009
pTRAN_other	1.054	1.059	1.057	1.065	1.061	1.067	1.014	1.020
pREBA	1.062	1.066	1.079	1.091	1.084	1.094	1.026	1.034
pRENT	1.072	1.116	1.073	1.082	1.096	1.115	1.015	1.022
pPUBO	1.039	1.043	1.063	1.071	1.064	1.070	0.996	1.002
pWAST	1.048	1.051	1.054	1.061	1.073	1.081	1.016	1.022
pRECY	1.067	1.071	1.049	1.054	1.053	1.057	1.020	1.025
pREPR_TXWO	1.042	1.045	1.058	1.066	1.064	1.070	1.015	1.022
pREPR_RUBP	1.082	1.088	1.062	1.070	1.086	1.095	1.014	1.020
pREPR_NMMP	1.037	1.039	1.059	1.067	1.060	1.066	1.016	1.022
pREPR_METP	1.042	1.045	1.052	1.059	1.049	1.054	1.016	1.021
pREPR_CONS	1.021	1.021	1.051	1.058	1.067	1.074	1.020	1.026

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.4 Household expenditures

Table 44 Household expenditures in mln euro of households in EU-27 on product level in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Industry	*Household expenditures in mln euro in 2030 in the baseline*	*Household expenditures in mln euro in 2030 in 'Circular Cities' scenario*	*Percentage change with respect to the baseline ('Circular Cities' Scenario)*
pPLNT	97,159	156,574	61.2%
pANIM	45,693	36,681	-19.7%
pFORE	11,276	11,125	-1.3%
pFISH	10,413	10,260	-1.5%
pFOSM	10,183	10,134	-0.5%
pOTHM	6,980	6,104	-12.5%
pFBTO	704,907	642,323	-8.9%
pTXWO	413,956	350,640	-15.3%
pCOKE	697	702	0.7%
pREFN	189,465	189,132	-0.2%
pCHEM	247,419	243,875	-1.4%
pRUBP	55,482	55,203	-0.5%
pNMMP	35,761	35,222	-1.5%
pMETP	134,048	134,045	0.0%
pELEC	338,093	303,082	-10.4%
pMACH	1,552,124	1,357,845	-12.5%
PELCT	64,032	64,069	0.1%
pTRDI	157,106	157,136	0.0%
pHWAT	11,070	11,144	0.7%
pWATR	30,130	29,345	-2.6%
pCONS	1,742,377	1,757,180	0.8%
pTRAD	209,616	209,521	0.0%
pHORE	686,668	729,695	6.3%
pTRAN_water	11,921	11,775	-1.2%
pTRAN_other	430,442	428,932	-0.4%
pREBA	2,127,270	2,186,299	2.8%
pRENT	38,820	247,226	536.9%
pPUBO	5,353,519	5,390,989	0.7%
pWAST	88,141	88,115	0.0%
pRECY	1,290	1,257	-2.6%
pREPR_TXWO	0	0	19.2%
pREPR_RUBP	0	0	25.2%
pREPR_NMMP	0	0	29.3%
pREPR_METP	0	0	3.8%
pREPR_CONS	0	0	2629.4%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.5 Production based raw material use (also known as DEU)

Table 45 Production based raw material use in kilotonnes in 2030 and percentage change in the CC-scenario. CC refers to 'Circular Cities' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CC	BAU	CC	BAU	CC	BAU	CC	BAU	CC
iPLNT	537,412	39.7%	1,793	40.8%	423	42.0%	245	34.4%	0	33.8%
iANIM	614,376	-55.8%	1,326	-51.5%	0	0.0%	11	-52.5%	0	0.0%
iFORE	181	-6.2%	258,947	-5.5%	466	-6.1%	151	-6.1%	0	-6.1%
iFISH	213	97.5%	35	97.5%	0	0.0%	0	0.0%	0	0.0%
iFOSM	135	-1.0%	1	-0.9%	705,476	-2.0%	134	-4.0%	0	-0.9%
iOTHM	591	-9.6%	70	-10.8%	1,212	-9.3%	3,413,374	-12.5%	189,420	-9.9%
iFBTO	2,036	-14.1%	158	-13.6%	359	-16.4%	629	-8.9%	0	-8.4%
iTXWO	311	-11.8%	3,235	-10.5%	689	-11.7%	138	-12.1%	1	-12.1%
iCOKE	0	0.0%	0	0.0%	76	0.6%	78	3.7%	0	-2.3%
iREFN	0	0.0%	0	0.0%	465	-0.1%	410	-0.8%	3	0.0%
iCHEM	122	-2.6%	25	-2.8%	4,116	-1.8%	10,251	-2.5%	490	-1.3%
iRUBP	16	-4.7%	9	-4.9%	716	-4.8%	168	-5.1%	0	-5.1%
iNMMP	102	-15.2%	0	0.0%	4,072	-14.3%	41,933	-15.6%	1,788	-15.8%
iMETP	50	-4.0%	27	-4.2%	8,891	-4.2%	6,295	-4.1%	409	-4.2%
iELEC	79	-6.8%	0	-6.8%	256	-6.7%	603	-6.8%	37	-6.8%
iMACH	275	-8.2%	432	-8.0%	1,153	-8.6%	450	-8.7%	25	-8.7%
iELCF	60	0.2%	12	0.1%	885	0.1%	91	0.1%	1	0.1%
iELCG	124	1.0%	48	1.1%	2,606	1.1%	580	1.1%	12	1.1%
iTRDI	147	1.3%	41	1.3%	4,900	0.8%	293	1.2%	3	1.3%
iHWAT	619	-0.2%	7	1.5%	831	0.3%	15	1.5%	0	1.5%
iWATR	14	-0.4%	3	-0.4%	0	-0.4%	65	-0.4%	0	-0.4%
iCONS	62	0.6%	405	0.7%	2,081	0.6%	22,780	0.4%	936	0.4%
iTRAD	6,971	-1.2%	1,485	-1.2%	11,535	-1.4%	27,722	-1.6%	300	-1.5%
iHORE	159	12.2%	412	12.2%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.0%	7	-1.0%	0	0.0%
iTRAN_other	748	-0.8%	684	-0.8%	6,740	-0.7%	15,009	-1.1%	1,090	-1.7%
iREBA	720	1.0%	783	1.2%	500	1.5%	683	1.5%	35	1.5%
iRENT	56	86.9%	5	87.2%	0	0.0%	84	86.4%	0	87.2%
iPUBO	1,024	1.2%	3,350	0.7%	522	1.2%	507	0.4%	0	1.2%
iWAST	3,343	-1.5%	486	-1.4%	16,600	-1.5%	3,233	-1.4%	2	-1.5%
iRECY	182	-2.9%	43	0.5%	22	-2.9%	4,450	-2.3%	113	-2.9%
iREPR_TXWO	131	29.9%	675	13.9%	774	29.8%	189	29.9%	0	29.9%
iREPR_RUBP	24	41.0%	8	41.1%	754	39.8%	6,726	19.8%	1,125	22.0%
iREPR_NMMP	59	27.8%	0	0.0%	1,899	30.6%	0	0.0%	147	23.6%
iREPR_METP	0	0.0%	0	0.0%	2,377	0.0%	2,374	0.3%	0	0.0%
iREPR_CONS	41	1474.7%	44	2142.2%	55	959.1%	267	1591.3%	25	2188.1%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.6 Consumption based raw material use

Table 46 Consumption based raw material use in kilotonnes in 2030 and percentage change in the CC-scenario. CC refers to 'Circular Cities' scenario. BAU refers to Business-as-Usual Baseline. The product definition is similar to industry definition.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CC	BAU	CC	BAU	CC	BAU	CC	BAU	CC
pPLNT	234,849	70.4%	1,701	83.9%	17,873	73.9%	34,457	65.5%	2,992	68.9%
pANIM	220,255	-21.2%	1,767	-21.5%	9,172	-21.1%	14,986	-22.2%	1,566	-21.0%
pFORE	879	-2.5%	73,258	-1.4%	1,734	-0.9%	3,285	-2.6%	313	-1.8%
pFISH	1,199	-7.3%	223	-4.7%	2,689	-2.5%	3,436	-3.7%	379	-2.3%
pFOSM	939	-4.8%	200	-0.4%	127,722	-0.2%	3,982	-2.4%	447	-1.1%
pOTHM	441	-13.2%	64	-13.5%	1,151	-13.0%	100,459	-13.0%	8,093	-11.8%
pFBTO	675,626	-20.6%	20,879	-7.4%	104,234	-10.5%	237,002	-10.9%	23,769	-9.5%
pTXWO	37,767	-20.1%	58,930	-19.2%	44,712	-17.1%	97,265	-18.7%	11,455	-18.0%
pCOKE	97	-3.1%	135	0.8%	4,568	0.7%	860	-0.6%	92	0.8%
pREFN	11,091	-1.1%	1,797	0.1%	441,326	0.2%	66,889	-1.2%	10,864	0.0%
pCHEM	18,190	-3.4%	3,029	-0.6%	55,986	-0.6%	164,883	-1.9%	14,290	-0.6%
pRUBP	2,494	-4.8%	1,693	0.2%	7,474	-2.7%	23,053	-4.9%	2,418	-3.7%
pNMMP	2,696	-2.9%	366	-0.2%	12,417	0.9%	116,295	-16.2%	5,656	-15.0%
pMETP	5,785	-1.1%	1,264	0.2%	25,467	1.0%	193,656	-3.5%	27,468	-2.9%
pELEC	10,859	-14.8%	2,723	-14.8%	35,902	-13.7%	134,902	-15.9%	19,772	-14.4%
pMACH	54,168	-18.2%	26,271	-16.7%	146,897	-16.8%	595,996	-19.0%	90,657	-17.6%
pELCT	4,251	-2.6%	1,549	0.1%	71,482	0.4%	25,771	-1.6%	3,387	-0.1%
pTRDI	7,466	-2.9%	1,810	-0.1%	139,002	0.1%	50,023	-1.9%	5,834	0.0%
pHWAT	1,915	-2.8%	680	-0.1%	28,465	0.9%	9,287	-0.8%	1,248	0.0%
pWATR	1,525	-4.3%	265	-2.4%	6,741	-2.2%	9,523	-5.1%	920	-3.1%
pCONS	64,587	0.4%	27,492	-4.7%	288,364	-0.5%	1,607,690	-19.5%	129,330	-10.0%
pTRAD	3,641	-1.1%	577	0.2%	7,523	0.5%	22,106	-0.6%	2,725	0.3%
pHORE	92,363	-15.5%	5,072	0.3%	46,235	4.2%	75,782	-1.9%	7,937	0.1%
pTRAN_water	599	-0.4%	54	0.2%	1,363	0.1%	1,554	-0.2%	171	1.9%
pTRAN_other	14,617	-1.8%	7,439	-0.1%	71,290	0.2%	73,878	-0.9%	7,405	0.4%
pREBA	52,302	0.0%	19,442	2.5%	144,086	3.6%	450,848	0.1%	36,355	2.3%
pRENT	1,057	609.2%	276	613.0%	3,141	650.7%	6,390	764.0%	850	809.4%
pPUBO	205,899	-2.8%	87,660	0.7%	383,299	1.1%	717,205	-2.3%	89,405	1.1%
pWAST	7,546	-1.0%	1,014	0.2%	19,797	0.5%	35,825	-1.7%	3,622	0.4%
pRECY	111	-3.7%	13	-2.4%	260	-2.2%	516	-3.0%	60	-1.7%
pREPR_TXWO	0	20.0%	0	19.6%	0	23.5%	0	18.8%	0	17.9%
pREPR_RUBP	0	31.3%	0	35.0%	0	38.6%	0	25.9%	0	24.3%
pREPR_NMMP	0	30.7%	0	31.7%	0	32.0%	0	23.0%	0	32.1%
pREPR_METP	0	2.1%	0	3.8%	0	3.6%	0	2.4%	0	4.2%
pREPR_CONS	0	3080.0%	0	3827.1%	0	2850.8%	0	3307.0%	0	3836.0%

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B.1.7 Production based secondary material use

Table 47 Production based secondary material use in kilotonnes in 2030 and percentage change in the CC-scenario. CC refers to 'Circular Cities' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Industry	Biomass		Fossil fuels		Non-metalic minerals		Metal ores	
	BAU	CC	BAU	CC	BAU	CC	BAU	CC
iPLNT	11,393	40.2%	0	50.2%	0	34.2%	0	33.8%
iANIM	12,933	-55.4%	0	0.0%	0	-52.5%	0	0.0%
iFORE	5	-6.2%	0	-6.1%	0	-6.1%	0	-6.1%
iFISH	6	97.5%	0	0.0%	0	0.0%	0	0.0%
iFOSM	4	-1.0%	1,513	-3.1%	0	-4.1%	0	-0.9%
iOTHM	15	-9.5%	1	-9.3%	0	0.0%	0	0.0%
iFBTO	52	-14.2%	0	-16.4%	1	-8.4%	0	-8.4%
iTXWO	8	-11.8%	1	-10.8%	0	-12.1%	0	-12.1%
iCOKE	0	0.0%	0	2.8%	0	3.7%	0	-2.3%
iREFN	0	0.0%	1	-0.4%	1	-0.8%	0	0.0%
iCHEM	3	-2.6%	17	-1.3%	16	-2.6%	1	-2.3%
iRUBP	0	-4.7%	1	-4.8%	0	-5.1%	0	-5.1%
iNMMP	3	-15.2%	3	-14.3%	4,299	-16.7%	2	-15.6%
iMETP	1	-4.0%	7	-4.1%	5	-4.1%	711	-3.7%
iELEC	2	-6.8%	0	-6.4%	0	-6.8%	0	-6.8%
iMACH	6	-8.3%	1	-8.4%	0	-8.7%	0	-8.7%
iELCF	2	0.2%	1	0.3%	0	0.1%	0	0.1%
iELCG	3	1.0%	2	0.9%	0	1.1%	0	1.1%
iTRDI	4	1.3%	11	0.1%	0	1.1%	0	1.3%
iHWAT	11	-0.1%	3	-0.3%	0	1.5%	0	1.5%
iWATR	0	-0.4%	0	-0.4%	0	-0.4%	0	-0.4%
iCONS	2	0.6%	2	0.6%	26	0.4%	1	0.5%
iTRAD	169	-1.2%	11	-1.5%	38	-1.7%	7	-1.7%
iHORE	4	12.2%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	-1.0%	0	0.0%
iTRAN_other	17	-0.8%	5	-0.7%	15	-1.3%	2	-1.6%
iREBA	17	1.1%	0	1.5%	1	1.5%	0	1.5%
iRENT	1	86.9%	0	0.0%	0	86.2%	0	87.2%
iPUBO	26	1.2%	0	1.1%	1	0.4%	0	1.1%
iWAST	87	-1.5%	12	-1.5%	3	-1.3%	0	-1.5%
iRECY	5	-2.9%	0	-2.9%	6	-2.0%	0	-2.9%
iREPR_TXWO	3	29.9%	1	29.3%	0	29.9%	0	29.9%
iREPR_RUBP	1	41.0%	1	34.6%	10	19.2%	1	20.8%
iREPR_NMMP	2	27.8%	1	30.6%	462,841	14.6%	0	24.9%
iREPR_METP	0	0.0%	2	-0.5%	2	0.3%	74,511	-0.6%
iREPR_CONS	1	1466.5%	0	959.1%	4,653	1634.1%	145	976.4%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.8 Production based GHG emmissions

Table 48 Production based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.

Industry	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Circular Cities' scenario*	*Percentage change with respect to the baseline ('Circular Cities' scenario)*
iPLNT	95,812	133,837	39.7%
iANIM	276,727	121,372	-56.1%
iFORE	3,043	2,885	-5.2%
iFISH	5,030	6,640	32.0%
iFOSM	63,894	62,703	-1.9%
iOTHM	4,504	3,974	-11.8%
iFBTO	36,702	32,888	-10.4%
iTXWO	34,628	30,759	-11.2%
iCOKE	15,344	15,030	-2.0%
iREFN	116,278	115,508	-0.7%
iCHEM	136,158	131,739	-3.2%
iRUBP	7,679	7,298	-5.0%
iNMMP	174,773	146,201	-16.3%
iMETP	167,670	161,357	-3.8%
iELEC	5,601	5,293	-5.5%
iMACH	20,874	19,242	-7.8%
iELCF	785,294	788,063	0.4%
iELCG	22,231	21,936	-1.3%
iTRDI	55,048	55,150	0.2%
iHWAT	7,696	7,762	0.9%
iWATR	555	552	-0.5%
iCONS	50,288	50,585	0.6%
iTRAD	65,774	64,866	-1.4%
iHORE	14,408	15,318	6.3%
iTRAN_water	85,777	84,247	-1.8%
iTRAN_other	275,199	271,371	-1.4%
iREBA	60,225	60,571	0.6%
iRENT	6,789	6,828	0.6%
iPUBO	96,663	97,179	0.5%
iWAST	175,217	173,482	-1.0%
iRECY	2,131	2,099	-1.5%
iREPR_TXWO	5,353	6,086	13.7%
iREPR_RUBP	4,789	5,656	18.1%
iREPR_NMMP	18,173	20,420	12.4%
iREPR_METP	1,643	1,632	-0.7%
iREPR_CONS	77	1,056	1279.3%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.1.9 Consumption based GHG emissions

Table 49 Consumption based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.The product definition is similar to industry definition.

Product	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Circular Cities' scenario*	*Percentage change with respect to the baseline ('Circular Cities' scenario)*
pPLNT	60,559	102,243	68.8%
pANIM	82,792	65,170	-21.3%
pFORE	2,949	2,912	-1.3%
pFISH	6,395	6,257	-2.2%
pFOSM	13,296	13,272	-0.2%
pOTHM	1,484	1,294	-12.8%
pFBTO	359,036	261,985	-27.0%
pTXWO	94,239	77,360	-17.9%
pCOKE	1,978	1,991	0.6%
pREFN	193,004	193,549	0.3%
pCHEM	105,776	104,726	-1.0%
pRUBP	14,969	14,592	-2.5%
pNMMP	29,730	30,066	1.1%
pMETP	59,452	59,946	0.8%
pELEC	68,483	59,251	-13.5%
pMACH	299,179	248,694	-16.9%
pELCT	214,559	215,131	0.3%
pTRDI	107,676	107,952	0.3%
pHWAT	37,114	37,435	0.9%
pWATR	10,656	10,403	-2.4%
pCONS	490,571	473,031	-3.6%
pTRAD	16,946	16,984	0.2%
pHORE	94,372	89,461	-5.2%
pTRAN_water	10,384	10,368	-0.2%
pTRAN_other	138,900	138,890	0.0%
pREBA	232,538	239,088	2.8%
pRENT	5,687	42,819	652.9%
pPUBO	689,707	690,726	0.1%
pWAST	85,498	85,570	0.1%
pRECY	365	356	-2.3%
pREPR_TXWO	0	0	21.0%
pREPR_RUBP	0	0	34.7%
pREPR_NMMP	0	0	30.2%
pREPR_METP	0	0	3.8%
pREPR_CONS	0	0	3016.5%

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B.2 Additional result tables: Circular Industries

B.2.1 Output

Table 50 Industry output in million euro for EU-27 in 2030. Industry definition can be found in Table 28

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Circular Industries' scenario*	*Percentage change with respect to the baseline ('Circular Industries' Scenario)*
iPLNT	242,368	235,139	-3.0%
iANIM	191,304	190,888	-0.2%
iFORE	39,992	37,235	-6.9%
iFISH	14,459	14,777	2.2%
iFOSM	75,915	61,380	-19.1%
iOTHM	279,950	197,454	-29.5%
iFBTO	993,075	985,833	-0.7%
iTXWO	890,984	708,755	-20.5%
iCOKE	7,379	8,156	10.5%
iREFN	373,483	340,062	-8.9%
iCHEM	540,838	459,791	-15.0%
iRUBP	342,870	299,467	-12.7%
iNMMP	242,179	212,232	-12.4%
iMETP	959,590	879,291	-8.4%
iELEC	759,602	686,249	-9.7%
iMACH	2,483,955	2,462,117	-0.9%
iELCF	143,312	106,141	-25.9%
iELCG	89,431	90,884	1.6%
iTRDI	407,391	417,369	2.4%
iHWAT	21,612	22,366	3.5%
iWATR	61,785	62,686	1.5%
iCONS	2,253,028	2,456,240	9.0%
iTRAD	1,658,665	1,667,103	0.5%
iHORE	902,568	871,533	-3.4%
iTRAN_water	123,939	115,260	-7.0%
iTRAN_other	1,771,849	1,774,822	0.2%
iREBA	4,255,127	4,242,789	-0.3%
iRENT	289,377	511,804	76.9%
iPUBO	6,976,864	7,001,135	0.3%
iWAST	226,988	229,189	1.0%
iRECY	63,628	63,632	0.0%
iREPR_TXWO	99,172	245,792	147.8%
iREPR_RUBP	86,751	221,985	155.9%
iREPR_NMMP	45,977	73,556	60.0%
iREPR_METP	157,093	192,049	22.3%
iREPR_CONS	7,428	6,706	-9.7%

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B.2.2 Employment

Table 51 Employment in 1000 p for EU-27 in 2030. Industry definition can be found in Table 28

Industry	*Total employment in 1000 p in 2030 in the baseline*	*Total employment in 1000 p in 2030 in 'Circular Industries' scenario*	*Percentage change with respect to the baseline ('Circular Industries' Scenario)*
iPLNT	5,870	5,890	0.3%
iANIM	2,783	2,833	1.8%
iFORE	1,284	1,233	-4.0%
iFISH	359	365	1.5%
iFOSM	161	128	-20.4%
iOTHM	597	435	-27.1%
iFBTO	4,029	4,054	0.6%
iTXWO	5,049	4,109	-18.6%
iCOKE	4	4	8.0%
iREFN	241	220	-8.7%
iCHEM	2,023	1,729	-14.5%
iRUBP	1,231	1,090	-11.4%
iNMMP	1,360	1,209	-11.1%
iMETP	4,553	4,186	-8.1%
iELEC	2,371	2,169	-8.5%
iMACH	10,090	10,143	0.5%
iELCF	348	249	-28.6%
iELCG	160	178	11.3%
iTRDI	844	893	5.7%
iHWAT	49	53	7.8%
iWATR	302	312	3.6%
iCONS	15,582	17,193	10.3%
iTRAD	30,208	30,707	1.7%
iHORE	9,727	9,470	-2.6%
iTRAN_water	306	287	-6.2%
iTRAN_other	9,592	9,718	1.3%
iREBA	26,552	26,933	1.4%
iRENT	620	1,217	96.3%
iPUBO	70,483	71,402	1.3%
iWAST	1,289	1,321	2.4%
iRECY	200	200	0.3%
iREPR_TXWO	610	1,559	155.5%
iREPR_RUBP	203	550	170.9%
iREPR_NMMP	231	372	61.2%
iREPR_METP	423	535	26.6%
iREPR_CONS	73	66	-9.6%

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B.2.3 Price indices

Table 52 Price indices for 4 EU-regions in 2030. Index equals 1 for all regions in 2011. CI refers to 'Circular Industries' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*NEU*	*SEU*	*WEU*	*EEU*	*NEU*	*SEU*	*WEU*	*EEU*
	BAU	CI	BAU	CI	BAU	CI	BAU	CI
pPLNT	1.065	1.079	1.083	1.126	1.086	1.121	1.030	1.079
pANIM	1.063	1.085	1.071	1.109	1.081	1.109	1.031	1.083
pFORE	1.084	1.121	1.082	1.135	1.069	1.099	1.017	1.073
pFISH	1.055	1.050	1.067	1.096	1.050	1.016	1.020	1.052
pFOSM	1.102	1.136	1.057	1.078	1.074	1.118	1.003	1.060
pOTHM	1.096	1.128	1.059	1.096	1.049	1.070	1.029	1.088
pFBTO	1.051	1.055	1.064	1.088	1.069	1.084	1.023	1.058
pTXWO	1.051	1.041	1.058	1.029	1.065	1.052	1.010	0.995
pCOKE	1.077	1.089	1.040	1.021	1.039	0.933	1.018	0.902
pREFN	1.068	1.083	1.072	1.083	1.072	1.087	1.014	1.040
pCHEM	1.070	1.082	1.060	1.062	1.070	1.075	1.017	1.016
pRUBP	1.053	1.042	1.057	1.030	1.065	1.062	1.014	0.964
pNMMP	1.055	1.044	1.060	1.055	1.060	1.050	1.017	1.005
pMETP	1.050	0.992	1.053	0.994	1.055	0.993	1.017	0.966
pELEC	1.044	1.044	1.057	1.054	1.057	1.061	1.014	1.008
pMACH	1.045	1.024	1.055	1.034	1.057	1.044	1.016	0.990
pELCT	1.062	1.080	1.074	1.115	1.083	1.122	1.026	1.078
pTRDI	1.062	1.000	1.067	1.054	1.076	1.058	1.029	1.021
pHWAT	1.056	1.031	1.068	1.100	1.068	1.040	1.022	1.016
pWATR	1.053	1.057	1.073	1.115	1.084	1.123	1.011	1.048
pCONS	1.043	1.002	1.062	1.052	1.063	1.037	1.021	1.011
pTRAD	1.049	1.097	1.062	1.117	1.067	1.113	1.016	1.096
pHORE	1.040	1.071	1.074	1.126	1.071	1.114	1.006	1.061
pTRAN_water	1.036	1.051	1.073	1.121	1.068	1.100	1.003	1.058
pTRAN_other	1.054	1.077	1.057	1.088	1.061	1.086	1.014	1.049
pREBA	1.062	1.091	1.079	1.136	1.084	1.129	1.026	1.091
pRENT	1.072	1.111	1.073	1.115	1.096	1.145	1.015	1.072
pPUBO	1.039	1.069	1.063	1.112	1.064	1.097	0.996	1.050
pWAST	1.048	1.059	1.054	1.084	1.073	1.105	1.016	1.057
pRECY	1.067	1.097	1.049	1.061	1.053	1.069	1.020	1.044
pREPR_TXWO	1.042	1.059	1.058	1.089	1.064	1.091	1.015	1.050
pREPR_RUBP	1.082	1.128	1.062	1.096	1.086	1.127	1.014	1.053
pREPR_NMMP	1.037	1.039	1.059	1.093	1.060	1.084	1.016	1.049
pREPR_METP	1.042	1.046	1.052	1.049	1.049	1.045	1.016	1.021
pREPR_CONS	1.021	1.016	1.051	1.072	1.067	1.106	1.020	1.058

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B.2.4 Household expenditures

Table 53 Household expenditures in mln euro of households in EU-27 on product level in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Circular Industries' scenario*	*Percentage change with respect to the baseline ('Circular Industries' Scenario)*
pPLNT	97,159	94,590	-2.6%
pANIM	45,693	46,482	1.7%
pFORE	11,276	11,084	-1.7%
pFISH	10,413	10,608	1.9%
pFOSM	10,183	9,712	-4.6%
pOTHM	6,980	4,552	-34.8%
pFBTO	704,907	708,327	0.5%
pTXWO	413,956	444,012	7.3%
pCOKE	697	851	22.1%
pREFN	189,465	192,863	1.8%
pCHEM	247,419	253,717	2.5%
pRUBP	55,482	60,107	8.3%
pNMMP	35,761	38,060	6.4%
pMETP	134,048	154,260	15.1%
pELEC	338,093	348,435	3.1%
pMACH	1,552,124	1,674,994	7.9%
PELCT	64,032	66,187	3.4%
pTRDI	157,106	168,653	7.3%
pHWAT	11,070	12,125	9.5%
pWATR	30,130	31,114	3.3%
pCONS	1,742,377	1,927,108	10.6%
pTRAD	209,616	213,028	1.6%
pHORE	686,668	683,839	-0.4%
pTRAN_water	11,921	11,709	-1.8%
pTRAN_other	430,442	439,857	2.2%
pREBA	2,127,270	2,174,633	2.2%
pRENT	38,820	39,625	2.1%
pPUBO	5,353,519	5,389,740	0.7%
pWAST	88,141	91,571	3.9%
pRECY	1,290	1,305	1.2%
pREPR_TXWO	0	0	226.3%
pREPR_RUBP	0	0	138.7%
pREPR_NMMP	0	0	189.5%
pREPR_METP	0	0	60.2%
pREPR_CONS	0	0	5.0%

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B.2.5 Production based raw material use (also known as DEU)

Table 54 Production based raw material use in kilotonnes in 2030 and percentage change in the CI-scenario. CI refers to 'Circular Industries' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CI	BAU	CI	BAU	CI	BAU	CI	BAU	CI
iPLNT	537,412	-2.3%	1,793	0.3%	423	1.0%	245	-4.9%	0	-5.4%
iANIM	614,376	-0.2%	1,326	-0.2%	0	0.0%	11	-1.0%	0	0.0%
iFORE	181	-5.0%	258,947	-7.2%	466	-5.0%	151	-5.0%	0	-5.0%
iFISH	213	-2.3%	35	-2.3%	0	0.0%	0	0.0%	0	0.0%
iFOSM	135	-22.3%	1	-22.6%	705,476	-20.0%	134	-18.5%	0	-22.6%
iOTHM	591	-27.4%	70	-29.8%	1,212	-27.5%	3,413,374	-29.5%	189,420	-25.7%
iFBTO	2,036	-0.5%	158	-0.3%	359	-1.2%	629	1.3%	0	-0.5%
iTXWO	311	-19.4%	3,235	-22.3%	689	-19.6%	138	-18.9%	1	-18.9%
iCOKE	0	0.0%	0	0.0%	76	7.1%	78	-3.2%	0	18.4%
iREFN	0	0.0%	0	0.0%	465	-14.3%	410	-9.4%	3	-15.0%
iCHEM	122	-14.6%	25	-14.8%	4,116	-13.0%	10,251	-13.0%	490	-12.1%
iRUBP	16	-6.7%	9	-6.4%	716	-6.4%	168	-13.6%	0	-16.1%
iNMMP	102	-11.3%	0	0.0%	4,072	-10.8%	41,933	-11.9%	1,788	-11.6%
iMETP	50	-10.8%	27	-11.9%	8,891	-11.7%	6,295	-11.4%	409	-11.8%
iELEC	79	-9.0%	0	-9.0%	256	-9.3%	603	-9.0%	37	-9.0%
iMACH	275	-0.9%	432	-1.3%	1,153	0.4%	450	0.8%	25	0.8%
iELCF	60	-34.2%	12	-35.0%	885	-33.0%	91	-35.0%	1	-35.0%
iELCG	124	36.9%	48	38.3%	2,606	36.9%	580	38.3%	12	38.3%
iTRDI	147	7.1%	41	7.1%	4,900	6.1%	293	6.9%	3	7.1%
iHWAT	619	2.0%	7	8.1%	831	3.2%	15	8.1%	0	8.1%
iWATR	14	3.5%	3	3.5%	0	3.5%	65	3.5%	0	3.5%
iCONS	62	9.7%	405	9.3%	2,081	9.8%	22,780	9.5%	936	9.5%
iTRAD	6,971	1.3%	1,485	1.1%	11,535	1.0%	27,722	-0.1%	300	0.2%
iHORE	159	-6.3%	412	-6.3%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.0%	7	-11.5%	0	0.0%
iTRAN_other	748	0.7%	684	0.8%	6,740	0.2%	15,009	0.0%	1,090	-0.1%
iREBA	720	0.4%	783	1.0%	500	1.1%	683	1.1%	35	1.1%
iRENT	56	179.4%	5	180.3%	0	0.0%	84	177.6%	0	180.3%
iPUBO	1,024	1.5%	3,350	0.8%	522	1.6%	507	0.3%	0	1.7%
iWAST	3,343	1.1%	486	1.1%	16,600	1.1%	3,233	1.1%	2	1.1%
iRECY	182	0.3%	43	4.5%	22	0.3%	4,450	-2.2%	113	0.3%
iREPR_TXWO	131	177.8%	675	185.2%	774	177.8%	189	177.8%	0	177.8%
iREPR_RUBP	24	181.0%	8	181.1%	754	174.7%	6,726	105.1%	1,125	53.8%
iREPR_NMMP	59	121.1%	0	0.0%	1,899	94.6%	0	0.0%	147	162.1%
iREPR_METP	0	0.0%	0	0.0%	2,377	50.4%	2,374	52.6%	0	0.0%
iREPR_CONS	41	1.3%	44	0.4%	55	1.8%	267	1.0%	25	0.3%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.2.6 Consumption based raw material use

Table 55 Consumption based raw material use in kilotonnes in 2030 and percentage change in the CI-scenario. CI refers to 'Circular Industries' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CI	BAU	CI	BAU	CI	BAU	CI	BAU	CI
pPLNT	234,849	-2.1%	1,701	-8.3%	17,873	-27.4%	34,457	-26.1%	2,992	-30.7%
pANIM	220,255	2.3%	1,767	-0.4%	9,172	-23.6%	14,986	-25.9%	1,566	-22.3%
pFORE	879	-3.1%	73,258	-1.8%	1,734	-25.0%	3,285	-35.3%	313	-28.3%
pFISH	1,199	-2.3%	223	-10.1%	2,689	-25.3%	3,436	-32.0%	379	-25.0%
pFOSM	939	-2.8%	200	-5.9%	127,722	-2.7%	3,982	-28.4%	447	-27.3%
pOTHM	441	-29.6%	64	-41.8%	1,151	-48.4%	100,459	-39.2%	8,093	-38.5%
pFBTO	675,626	2.1%	20,879	-5.2%	104,234	-23.2%	237,002	-25.2%	23,769	-23.4%
pTXWO	37,767	-8.7%	58,930	-1.4%	44,712	-24.9%	97,265	-31.3%	11,455	-30.7%
pCOKE	97	11.7%	135	20.3%	4,568	-16.5%	860	-19.1%	92	-18.0%
pREFN	11,091	1.9%	1,797	-1.7%	441,326	2.4%	66,889	-17.1%	10,864	-11.8%
pCHEM	18,190	65.1%	3,029	123.5%	55,986	-25.5%	164,883	-28.6%	14,290	-26.0%
pRUBP	2,494	-1.1%	1,693	2.9%	7,474	-26.8%	23,053	-31.4%	2,418	-32.6%
pNMMP	2,696	2.0%	366	-9.2%	12,417	-8.9%	116,295	-15.9%	5,656	-14.3%
pMETP	5,785	-4.8%	1,264	-11.8%	25,467	-20.4%	193,656	-20.3%	27,468	-23.3%
pELEC	10,859	-5.1%	2,723	-16.8%	35,902	-22.4%	134,902	-31.7%	19,772	-31.1%
pMACH	54,168	-5.2%	26,271	-8.5%	146,897	-23.7%	595,996	-32.5%	90,657	-32.5%
pELCT	4,251	8.4%	1,549	16.6%	71,482	-12.4%	25,771	-19.6%	3,387	-16.6%
pTRDI	7,466	-1.0%	1,810	-3.9%	139,002	-23.8%	50,023	-24.3%	5,834	-23.2%
pHWAT	1,915	8.8%	680	-0.7%	28,465	-9.6%	9,287	-22.1%	1,248	-20.5%
pWATR	1,525	2.3%	265	-6.4%	6,741	-18.6%	9,523	-30.9%	920	-27.4%
pCONS	64,587	-8.8%	27,492	-19.1%	288,364	-19.6%	1,607,690	-31.8%	129,330	-29.7%
pTRAD	3,641	2.8%	577	-4.6%	7,523	-17.8%	22,106	-10.7%	2,725	-8.2%
pHORE	92,363	3.8%	5,072	-9.3%	46,235	-18.4%	75,782	-22.0%	7,937	-19.4%
pTRAN_water	599	6.1%	54	-4.6%	1,363	-13.7%	1,554	-21.3%	171	-9.4%
pTRAN_other	14,617	2.9%	7,439	-0.5%	71,290	-20.9%	73,878	-15.9%	7,405	-15.4%
pREBA	52,302	-0.8%	19,442	-18.2%	144,086	-17.0%	450,848	-15.8%	36,355	-19.5%
pRENT	1,057	2.4%	276	-13.4%	3,141	-21.5%	6,390	-22.0%	850	-18.2%
pPUBO	205,899	-4.6%	87,660	-12.1%	383,299	-27.0%	717,205	-29.5%	89,405	-28.1%
pWAST	7,546	3.9%	1,014	-6.2%	19,797	-13.2%	35,825	-24.4%	3,622	-19.5%
pRECY	111	2.7%	13	-6.0%	260	-18.3%	516	-13.9%	60	-15.4%
pREPR_TXWO	0	205.8%	0	175.4%	0	153.4%	0	129.1%	0	148.2%
pREPR_RUBP	0	202.8%	0	143.2%	0	151.9%	0	109.4%	0	103.6%
pREPR_NMMP	0	230.1%	0	160.8%	0	126.1%	0	52.2%	0	149.6%
pREPR_METP	0	60.2%	0	32.9%	0	24.3%	0	16.9%	0	15.5%
pREPR_CONS	0	5.6%	0	2.8%	0	-21.6%	0	-12.4%	0	-9.3%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.2.7 Production based secondary material use

Table 56 Production based secondary material use in kilotonnes in 2030 and percentage change in the CI-scenario. CI refers to 'Circular Industries' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Industry	Biomass		Fossil fuels		Non-metalic minerals		Metal ores	
	BAU	CI	BAU	CI	BAU	CI	BAU	CI
iPLNT	11,393	-1.8%	0	2.0%	0	-5.0%	0	-5.4%
iANIM	12,933	-0.1%	0	0.0%	0	-1.0%	0	0.0%
iFORE	5	-5.0%	0	-5.0%	0	-5.0%	0	-5.0%
iFISH	6	-2.3%	0	0.0%	0	0.0%	0	0.0%
iFOSM	4	-22.3%	1,513	-18.1%	0	-18.1%	0	-22.6%
iOTHM	15	-27.3%	1	-27.5%	0	0.0%	0	0.0%
iFBTO	52	-0.5%	0	-1.2%	1	1.4%	0	-0.5%
iTXWO	8	-19.4%	1	-21.6%	0	-18.9%	0	-18.9%
iCOKE	0	0.0%	0	-1.2%	0	-3.2%	0	18.4%
iREFN	0	0.0%	1	-12.0%	1	-9.5%	0	-15.0%
iCHEM	3	-14.6%	17	-12.2%	16	-13.0%	1	-12.7%
iRUBP	0	-6.7%	1	-6.5%	0	-14.8%	0	-16.1%
iNMMP	3	-11.3%	3	-10.8%	4,299	-12.2%	2	-11.5%
iMETP	1	-10.7%	7	-11.3%	5	-11.2%	711	-8.6%
iELEC	2	-9.0%	0	-9.8%	0	-9.0%	0	-9.0%
iMACH	6	-0.7%	1	-0.3%	0	0.8%	0	0.7%
iELCF	2	-34.4%	1	-25.1%	0	-35.0%	0	-35.0%
iELCG	3	37.3%	2	29.3%	0	38.3%	0	38.3%
iTRDI	4	7.1%	11	4.4%	0	6.6%	0	7.1%
iHWAT	11	2.0%	3	0.7%	0	8.1%	0	8.1%
iWATR	0	3.5%	0	3.5%	0	3.5%	0	3.5%
iCONS	2	9.8%	2	9.8%	26	9.4%	1	9.6%
iTRAD	169	1.3%	11	0.7%	38	-0.4%	7	-0.6%
iHORE	4	-6.3%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	-11.5%	0	0.0%
iTRAN_other	17	0.5%	5	0.1%	15	-0.1%	2	-0.2%
iREBA	17	0.6%	0	1.1%	1	1.1%	0	1.1%
iRENT	1	179.4%	0	0.0%	0	176.7%	0	180.3%
iPUBO	26	1.6%	0	1.5%	1	0.3%	0	1.4%
iWAST	87	1.1%	12	1.1%	3	1.0%	0	1.1%
iRECY	5	0.3%	0	0.3%	6	-3.0%	0	0.2%
iREPR_TXWO	3	177.8%	1	178.1%	0	177.8%	0	177.8%
iREPR_RUBP	1	181.0%	1	142.8%	10	112.0%	1	78.3%
iREPR_NMMP	2	121.2%	1	94.6%	462,841	78.4%	0	149.8%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.2.8 Production based GHG emmissions

Table 57 Production based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.

Industry	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Circular Industries' scenario*	*Percentage change with respect to the baseline ('Circular Industries' scenario)*
iPLNT	95,812	79,718	-16.8%
iANIM	276,727	270,558	-2.2%
iFORE	3,043	1,951	-35.9%
iFISH	5,030	3,545	-29.5%
iFOSM	63,894	50,659	-20.7%
iOTHM	4,504	2,839	-37.0%
iFBTO	36,702	25,181	-31.4%
iTXWO	34,628	19,078	-44.9%
iCOKE	15,344	11,769	-23.3%
iREFN	116,278	105,553	-9.2%
iCHEM	136,158	76,688	-43.7%
iRUBP	7,679	4,798	-37.5%
iNMMP	174,773	132,627	-24.1%
iMETP	167,670	105,663	-37.0%
iELEC	5,601	3,529	-37.0%
iMACH	20,874	14,412	-31.0%
iELCF	785,294	564,609	-28.1%
iELCG	22,231	22,738	2.3%
iTRDI	55,048	39,870	-27.6%
iHWAT	7,696	5,589	-27.4%
iWATR	555	391	-29.5%
iCONS	50,288	38,222	-24.0%
iTRAD	65,774	45,948	-30.1%
iHORE	14,408	9,596	-33.4%
iTRAN_water	85,777	56,136	-34.6%
iTRAN_other	275,199	190,825	-30.7%
iREBA	60,225	41,567	-31.0%
iRENT	6,789	8,669	27.7%
iPUBO	96,663	67,177	-30.5%
iWAST	175,217	170,145	-2.9%
iRECY	2,131	1,497	-29.7%
iREPR_TXWO	5,353	9,457	76.7%
iREPR_RUBP	4,789	9,409	96.5%
iREPR_NMMP	18,173	24,987	37.5%
iREPR_METP	1,643	1,442	-12.2%
iREPR_CONS	77	52	-32.6%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.2.9 Consumption based GHG emissions

Table 58 Consumption based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Circular Industries' scenario*	*Percentage change with respect to the baseline ('Circular Industries' scenario)*
pPLNT	60,559	49,073	-19.0%
pANIM	82,792	79,727	-3.7%
pFORE	2,949	2,198	-25.5%
pFISH	6,395	4,740	-25.9%
pFOSM	13,296	12,571	-5.5%
pOTHM	1,484	828	-44.2%
pFBTO	359,036	311,697	-13.2%
pTXWO	94,239	69,917	-25.8%
pCOKE	1,978	1,670	-15.6%
pREFN	193,004	192,969	0.0%
pCHEM	105,776	77,773	-26.5%
pRUBP	14,969	10,617	-29.1%
pNMMP	29,730	26,417	-11.1%
pMETP	59,452	46,121	-22.4%
pELEC	68,483	51,116	-25.4%
pMACH	299,179	219,813	-26.5%
pELCT	214,559	182,261	-15.1%
pTRDI	107,676	79,470	-26.2%
pHWAT	37,114	38,001	2.4%
pWATR	10,656	9,196	-13.7%
pCONS	490,571	377,445	-23.1%
pTRAD	16,946	13,306	-21.5%
pHORE	94,372	77,327	-18.1%
pTRAN_water	10,384	8,132	-21.7%
pTRAN_other	138,900	105,888	-23.8%
pREBA	232,538	183,693	-21.0%
pRENT	5,687	4,522	-20.5%
pPUBO	689,707	511,869	-25.8%
pWAST	85,498	82,313	-3.7%
pRECY	365	308	-15.7%
pREPR_TXWO	0	0	145.9%
pREPR_RUBP	0	0	122.4%
pREPR_NMMP	0	0	139.5%
pREPR_METP	0	0	21.9%
pREPR_CONS	0	0	-16.1%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3 Additional result tables: Closing the loop

B.3.1 Output

Table 59 Industry output in million euro for EU-27 in 2030. Industry definition can be found in Table 28

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Closing the loop' scenario*	*Percentage change with respect to the baseline ('Closing the loop' Scenario)*
iPLNT	242,368	239,231	-1.3%
iANIM	191,304	190,693	-0.3%
iFORE	39,992	38,805	-3.0%
iFISH	14,459	14,350	-0.8%
iFOSM	75,915	75,648	-0.4%
iOTHM	279,950	245,478	-12.3%
iFBTO	993,075	988,969	-0.4%
iTXWO	890,984	830,612	-6.8%
iCOKE	7,379	7,523	2.0%
iREFN	373,483	373,749	0.1%
iCHEM	540,838	503,003	-7.0%
iRUBP	342,870	341,990	-0.3%
iNMMP	242,179	243,283	0.5%
iMETP	959,590	967,326	0.8%
iELEC	759,602	744,244	-2.0%
iMACH	2,483,955	2,462,799	-0.9%
iELCF	143,312	144,101	0.6%
iELCG	89,431	90,050	0.7%
iTRDI	407,391	408,708	0.3%
iHWAT	21,612	21,623	0.0%
iWATR	61,785	61,978	0.3%
iCONS	2,253,028	2,256,240	0.1%
iTRAD	1,658,665	1,661,707	0.2%
iHORE	902,568	903,130	0.1%
iTRAN_water	123,939	125,879	1.6%
iTRAN_other	1,771,849	1,782,297	0.6%
iREBA	4,255,127	4,254,100	0.0%
iRENT	289,377	288,139	-0.4%
iPUBO	6,976,864	6,965,067	-0.2%
iWAST	226,988	235,826	3.9%
iRECY	63,628	66,236	4.1%
iREPR_TXWO	99,172	165,415	66.8%
iREPR_RUBP	86,751	132,989	53.3%
iREPR_NMMP	45,977	60,134	30.8%
iREPR_METP	157,093	194,851	24.0%
iREPR_CONS	7,428	6,919	-6.8%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.2 Employment

Table 60 Employment in 1000 p for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Closing the loop' scenario*	*Percentage change with respect to the baseline ('Closing the loop' Scenario)*
iPLNT	5,870	5,812	-1.0%
iANIM	2,783	2,776	-0.2%
iFORE	1,284	1,263	-1.6%
iFISH	359	357	-0.7%
iFOSM	161	161	-0.1%
iOTHM	597	540	-9.5%
iFBTO	4,029	4,014	-0.4%
iTXWO	5,049	4,773	-5.5%
iCOKE	4	4	1.9%
iREFN	241	241	0.0%
iCHEM	2,023	1,878	-7.2%
iRUBP	1,231	1,228	-0.2%
iNMMP	1,360	1,366	0.5%
iMETP	4,553	4,588	0.8%
iELEC	2,371	2,324	-2.0%
iMACH	10,090	10,001	-0.9%
iELCF	348	350	0.6%
iELCG	160	161	0.7%
iTRDI	844	847	0.4%
iHWAT	49	49	0.0%
iWATR	302	304	0.7%
iCONS	15,582	15,613	0.2%
iTRAD	30,208	30,255	0.2%
iHORE	9,727	9,738	0.1%
iTRAN_water	306	310	1.2%
iTRAN_other	9,592	9,644	0.5%
iREBA	26,552	26,558	0.0%
iRENT	620	618	-0.3%
iPUBO	70,483	70,382	-0.1%
iWAST	1,289	1,341	4.0%
iRECY	200	207	3.5%
iREPR_TXWO	610	1,025	68.0%
iREPR_RUBP	203	320	57.5%
iREPR_NMMP	231	302	30.8%
iREPR_METP	423	531	25.5%
iREPR_CONS	73	67	-7.4%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.3 Price indices

Table 61 Price indices for 4 EU-regions in 2030. Index equals 1 for all regions in 2011. CL refers to 'Closing the loop' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*NEU*	*SEU*	*WEU*	*EEU*	*NEU*	*SEU*	*WEU*	*EEU*
	BAU	CL	BAU	CL	BAU	CL	BAU	CL
pPLNT	1.065	1.068	1.083	1.089	1.086	1.090	1.030	1.037
pANIM	1.063	1.065	1.071	1.077	1.081	1.085	1.031	1.038
pFORE	1.084	1.086	1.082	1.088	1.069	1.076	1.017	1.024
pFISH	1.055	1.058	1.067	1.072	1.050	1.053	1.020	1.026
pFOSM	1.102	1.103	1.057	1.067	1.074	1.077	1.003	1.010
pOTHM	1.096	1.097	1.059	1.065	1.049	1.053	1.029	1.036
pFBTO	1.051	1.054	1.064	1.069	1.069	1.072	1.023	1.029
pTXWO	1.051	1.053	1.058	1.063	1.065	1.069	1.010	1.013
pCOKE	1.077	1.079	1.040	1.045	1.039	1.043	1.018	1.023
pREFN	1.068	1.070	1.072	1.072	1.072	1.073	1.014	1.019
pCHEM	1.070	1.070	1.060	1.064	1.070	1.072	1.017	1.019
pRUBP	1.053	1.051	1.057	1.060	1.065	1.066	1.014	1.012
pNMMP	1.055	1.055	1.060	1.065	1.060	1.064	1.017	1.021
pMETP	1.050	1.050	1.053	1.059	1.055	1.060	1.017	1.023
pELEC	1.044	1.052	1.057	1.071	1.057	1.068	1.014	1.023
pMACH	1.045	1.048	1.055	1.061	1.057	1.061	1.016	1.021
pELCT	1.062	1.064	1.074	1.080	1.083	1.087	1.026	1.032
pTRDI	1.062	1.064	1.067	1.072	1.076	1.080	1.029	1.035
pHWAT	1.056	1.058	1.068	1.073	1.068	1.071	1.022	1.027
pWATR	1.053	1.056	1.073	1.079	1.084	1.088	1.011	1.018
pCONS	1.043	1.044	1.062	1.068	1.063	1.067	1.021	1.026
pTRAD	1.049	1.052	1.062	1.068	1.067	1.070	1.016	1.023
pHORE	1.040	1.043	1.074	1.080	1.071	1.075	1.006	1.013
pTRAN_water	1.036	1.038	1.073	1.078	1.068	1.071	1.003	1.010
pTRAN_other	1.054	1.056	1.057	1.062	1.061	1.064	1.014	1.020
pREBA	1.062	1.064	1.079	1.085	1.084	1.088	1.026	1.033
pRENT	1.072	1.075	1.073	1.079	1.096	1.100	1.015	1.022
pPUBO	1.039	1.042	1.063	1.068	1.064	1.067	0.996	1.003
pWAST	1.048	1.051	1.054	1.060	1.073	1.077	1.016	1.022
pRECY	1.067	1.069	1.049	1.054	1.053	1.055	1.020	1.025
pREPR_TXWO	1.042	1.049	1.058	1.070	1.064	1.073	1.015	1.019
pREPR_RUBP	1.082	1.089	1.062	1.072	1.086	1.093	1.014	1.018
pREPR_NMMP	1.037	1.048	1.059	1.072	1.060	1.073	1.016	1.019
pREPR_METP	1.042	1.054	1.052	1.065	1.049	1.069	1.016	1.019
pREPR_CONS	1.021	1.043	1.051	1.075	1.067	1.077	1.020	1.025

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.4 Household expenditures

Table 62 Household expenditures in mln euro of households in EU-27 on product level in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Closing the loop' scenario*	*Percentage change with respect to the baseline ('Closing the loop' Scenario)*
pPLNT	97,159	96,388	-0.8%
pANIM	45,693	45,684	0.0%
pFORE	11,276	11,141	-1.2%
pFISH	10,413	10,352	-0.6%
pFOSM	10,183	10,149	-0.3%
pOTHM	6,980	5,940	-14.9%
pFBTO	704,907	702,977	-0.3%
pTXWO	413,956	411,940	-0.5%
pCOKE	697	706	1.2%
pREFN	189,465	189,051	-0.2%
pCHEM	247,419	245,628	-0.7%
pRUBP	55,482	55,583	0.2%
pNMMP	35,761	35,621	-0.4%
pMETP	134,048	133,483	-0.4%
pELEC	338,093	329,863	-2.4%
pMACH	1,552,124	1,540,594	-0.7%
PELCT	64,032	64,091	0.1%
pTRDI	157,106	157,231	0.1%
pHWAT	11,070	11,099	0.3%
pWATR	30,130	30,141	0.0%
pCONS	1,742,377	1,745,509	0.2%
pTRAD	209,616	209,474	-0.1%
pHORE	686,668	684,027	-0.4%
pTRAN_water	11,921	11,868	-0.4%
pTRAN_other	430,442	429,575	-0.2%
pREBA	2,127,270	2,129,010	0.1%
pRENT	38,820	38,801	0.0%
pPUBO	5,353,519	5,346,012	-0.1%
pWAST	88,141	88,155	0.0%
pRECY	1,290	1,345	4.2%
pREPR_TXWO	0	0	111.7%
pREPR_RUBP	0	0	46.8%
pREPR_NMMP	0	0	94.7%
pREPR_METP	0	0	46.8%
pREPR_CONS	0	0	-0.1%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.5 Production based raw material use (also known as DEU)

Table 63 Production based raw material use in kilotonnes in 2030 and percentage change in the CL-scenario. CL refers to 'Closing the loop' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CL	BAU	CL	BAU	CL	BAU	CL	BAU	CL
iPLNT	537,412	-1.2%	1,793	-0.7%	423	-0.6%	245	-1.6%	0	-1.7%
iANIM	614,376	-0.3%	1,326	-0.2%	0	0.0%	11	-0.5%	0	0.0%
iFORE	181	-1.0%	258,947	-3.1%	466	-0.9%	151	-0.9%	0	-0.9%
iFISH	213	-0.7%	35	-0.7%	0	0.0%	0	0.0%	0	0.0%
iFOSM	135	0.0%	1	0.0%	705,476	-0.3%	134	0.1%	0	0.0%
iOTHM	591	-7.3%	70	-9.2%	1,212	-6.2%	3,413,374	-12.1%	189,420	-9.0%
iFBTO	2,036	-0.3%	158	-0.2%	359	-0.3%	629	0.0%	0	-0.4%
iTXWO	311	-3.4%	3,235	-10.0%	689	-4.0%	138	-2.3%	1	-2.3%
iCOKE	0	0.0%	0	0.0%	76	1.4%	78	6.8%	0	-3.7%
iREFN	0	0.0%	0	0.0%	465	-0.6%	410	0.2%	3	-0.7%
iCHEM	122	-9.2%	25	-9.5%	4,116	-7.0%	10,251	-6.8%	490	-5.7%
iRUBP	16	0.0%	9	-0.1%	716	-0.1%	168	-0.3%	0	-0.4%
iNMMP	102	0.5%	0	0.0%	4,072	0.3%	41,933	0.5%	1,788	0.6%
iMETP	50	0.1%	27	0.0%	8,891	0.0%	6,295	0.1%	409	0.0%
iELEC	79	-1.9%	0	-1.9%	256	-2.0%	603	-1.9%	37	-1.9%
iMACH	275	-0.9%	432	-0.9%	1,153	-1.1%	450	-1.2%	25	-1.2%
iELCF	60	0.4%	12	0.4%	885	0.5%	91	0.4%	1	0.4%
iELCG	124	0.4%	48	0.4%	2,606	0.5%	580	0.4%	12	0.4%
iTRDI	147	0.2%	41	0.2%	4,900	0.4%	293	0.2%	3	0.2%
iHWAT	619	0.0%	7	0.1%	831	0.2%	15	0.1%	0	0.1%
iWATR	14	1.5%	3	1.5%	0	1.5%	65	1.5%	0	1.5%
iCONS	62	0.3%	405	0.2%	2,081	0.3%	22,780	0.2%	936	0.2%
iTRAD	6,971	0.0%	1,485	-0.1%	11,535	-0.1%	27,722	0.1%	300	0.0%
iHORE	159	0.0%	412	0.0%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.0%	7	-1.2%	0	0.0%
iTRAN_other	748	0.4%	684	0.5%	6,740	0.2%	15,009	0.3%	1,090	0.5%
iREBA	720	0.0%	783	0.0%	500	0.1%	683	0.1%	35	0.1%
iRENT	56	0.1%	5	0.1%	0	0.0%	84	0.1%	0	0.1%
iPUBO	1,024	-0.1%	3,350	-0.1%	522	-0.1%	507	-0.2%	0	-0.1%
iWAST	3,343	5.2%	486	4.5%	16,600	5.2%	3,233	6.0%	2	5.2%
iRECY	182	3.2%	43	3.5%	22	3.2%	4,450	2.1%	113	3.2%
iREPR_TXWO	131	80.1%	675	102.7%	774	80.2%	189	80.1%	0	80.1%
iREPR_RUBP	24	62.2%	8	62.2%	754	59.7%	6,726	33.0%	1,125	10.6%
iREPR_NMMP	59	57.4%	0	0.0%	1,899	40.9%	0	0.0%	147	83.0%
iREPR_METP	0	0.0%	0	0.0%	2,377	30.2%	2,374	31.3%	0	0.0%
iREPR_CONS	41	-0.3%	44	-0.5%	55	-0.2%	267	-0.4%	25	-0.5%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.6 Consumption based raw material use

Table 64 Consumption based raw material use in kilotonnes in 2030 and percentage change in the CL-scenario. CL refers to 'Closing the loop' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CL	BAU	CL	BAU	CL	BAU	CL	BAU	CL
pPLNT	234,849	-0.8%	1,701	-1.7%	17,873	-3.0%	34,457	-7.5%	2,992	-19.0%
pANIM	220,255	0.0%	1,767	-0.2%	9,172	-1.1%	14,986	-6.8%	1,566	-12.1%
pFORE	879	-7.6%	73,258	-1.2%	1,734	-6.9%	3,285	-13.4%	313	-19.4%
pFISH	1,199	-2.7%	223	-4.0%	2,689	-2.8%	3,436	-4.9%	379	-12.0%
pFOSM	939	-2.2%	200	-0.4%	127,722	-0.2%	3,982	-5.1%	447	-11.9%
pOTHM	441	-16.7%	64	-15.6%	1,151	-15.2%	100,459	-14.6%	8,093	-15.1%
pFBTO	675,626	-0.1%	20,879	-1.5%	104,234	-2.4%	237,002	-6.2%	23,769	-12.6%
pTXWO	37,767	-13.2%	58,930	-3.5%	44,712	-7.3%	97,265	-14.1%	11,455	-24.0%
pCOKE	97	-2.1%	135	0.2%	4,568	0.1%	860	-1.3%	92	-6.9%
pREFN	11,091	-4.6%	1,797	-4.2%	441,326	-1.1%	66,889	-6.4%	10,864	-9.8%
pCHEM	18,190	-9.7%	3,029	-12.1%	55,986	-5.2%	164,883	-19.3%	14,290	-25.2%
pRUBP	2,494	-19.3%	1,693	-4.6%	7,474	-11.7%	23,053	-18.9%	2,418	-27.6%
pNMMP	2,696	-5.5%	366	-5.2%	12,417	-1.0%	116,295	-9.1%	5,656	-13.9%
pMETP	5,785	-11.8%	1,264	-9.4%	25,467	-3.7%	193,656	-9.8%	27,468	-22.0%
pELEC	10,859	-7.9%	2,723	-12.3%	35,902	-2.6%	134,902	-8.9%	19,772	-10.9%
pMACH	54,168	-6.0%	26,271	-2.2%	146,897	-2.9%	595,996	-6.0%	90,657	-11.5%
pELCT	4,251	-2.7%	1,549	-0.6%	71,482	-0.4%	25,771	-4.4%	3,387	-9.8%
pTRDI	7,466	-2.6%	1,810	-1.4%	139,002	-0.8%	50,023	-3.5%	5,834	-11.0%
pHWAT	1,915	-0.8%	680	1.0%	28,465	0.0%	9,287	-0.6%	1,248	-5.3%
pWATR	1,525	-2.2%	265	-2.0%	6,741	-0.9%	9,523	-4.5%	920	-11.4%
pCONS	64,587	-10.6%	27,492	-14.7%	288,364	-1.6%	1,607,690	-19.8%	129,330	-18.2%
pTRAD	3,641	-1.2%	577	-2.1%	7,523	-1.6%	22,106	-2.0%	2,725	-4.0%
pHORE	92,363	-0.1%	5,072	-2.1%	46,235	-1.6%	75,782	-5.7%	7,937	-10.5%
pTRAN_water	599	0.1%	54	-0.6%	1,363	-0.9%	1,554	-1.6%	171	-3.4%
pTRAN_other	14,617	-1.1%	7,439	-0.9%	71,290	-0.9%	73,878	-5.1%	7,405	-6.0%
pREBA	52,302	-3.5%	19,442	-2.1%	144,086	-1.8%	450,848	-5.3%	36,355	-10.3%
pRENT	1,057	-4.2%	276	-3.6%	3,141	-2.8%	6,390	-7.0%	850	-10.3%
pPUBO	205,899	-4.6%	87,660	-1.7%	383,299	-4.2%	717,205	-8.5%	89,405	-15.4%
pWAST	7,546	-2.0%	1,014	-3.1%	19,797	-1.4%	35,825	-3.9%	3,622	-10.9%
pRECY	111	1.9%	13	2.2%	260	2.1%	516	-0.3%	60	-7.8%
pREPR_TXWO	0	41.6%	0	138.2%	0	93.5%	0	69.1%	0	73.2%
pREPR_RUBP	0	27.0%	0	85.3%	0	66.4%	0	34.9%	0	29.8%
pREPR_NMMP	0	17.0%	0	120.4%	0	56.5%	0	13.8%	0	65.0%
pREPR_METP	0	-13.5%	0	60.8%	0	22.3%	0	10.0%	0	-0.3%
pREPR_CONS	0	-33.7%	0	-0.5%	0	-2.1%	0	-9.7%	0	-11.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.7 Production based secondary material use

Table 65 Production based secondary material use in kilotonnes in 2030 and percentage change in the CL-scenario. CL refers to 'Closing the loop' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Industry	*Biomass*		*Fossil fuels*		*Non-metalic minerals*		*Metal ores*	
	BAU	CL	BAU	CL	BAU	CL	BAU	CL
iPLNT	11,393	-1.1%	0	-0.5%	0	-1.6%	0	-1.7%
iANIM	12,933	-0.3%	0	0.0%	0	-0.5%	0	0.0%
iFORE	5	-0.9%	0	-0.9%	0	-0.9%	0	-0.9%
iFISH	6	-0.7%	0	0.0%	0	0.0%	0	0.0%
iFOSM	4	0.0%	1,513	-0.3%	0	0.1%	0	0.0%
iOTHM	15	-7.1%	1	-6.2%	0	0.0%	0	0.0%
iFBTO	52	-0.3%	0	-0.3%	1	0.0%	0	-0.4%
iTXWO	8	-3.3%	1	-8.4%	0	-2.3%	0	-2.3%
iCOKE	0	0.0%	0	5.3%	0	6.8%	0	-3.7%
iREFN	0	0.0%	1	-0.2%	1	0.1%	0	-0.7%
iCHEM	3	-9.2%	17	-5.9%	16	-6.8%	1	-6.5%
iRUBP	0	0.0%	1	0.0%	0	-0.3%	0	-0.4%
iNMMP	3	0.5%	3	0.3%	4,299	0.4%	2	0.6%
iMETP	1	0.1%	7	0.1%	5	0.1%	711	0.7%
iELEC	2	-1.9%	0	-2.1%	0	-1.9%	0	-1.9%
iMACH	6	-1.0%	1	-1.0%	0	-1.2%	0	-1.1%
iELCF	2	0.4%	1	1.0%	0	0.4%	0	0.4%
iELCG	3	0.4%	2	0.7%	0	0.4%	0	0.4%
iTRDI	4	0.2%	11	0.6%	0	0.2%	0	0.2%
iHWAT	11	0.0%	3	0.3%	0	0.1%	0	0.1%
iWATR	0	1.5%	0	1.5%	0	1.5%	0	1.5%
iCONS	2	0.3%	2	0.3%	26	0.2%	1	0.2%
iTRAD	169	-0.1%	11	0.0%	38	0.1%	7	0.2%
iHORE	4	0.0%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	-1.2%	0	0.0%
iTRAN_other	17	0.4%	5	0.2%	15	0.4%	2	0.5%
iREBA	17	0.0%	0	0.1%	1	0.1%	0	0.1%
iRENT	1	0.1%	0	0.0%	0	0.1%	0	0.1%
iPUBO	26	-0.1%	0	-0.1%	1	-0.2%	0	-0.1%
iWAST	87	5.2%	12	5.2%	3	6.4%	0	5.2%
iRECY	5	3.2%	0	3.2%	6	1.7%	0	3.1%
iREPR_TXWO	3	80.1%	1	81.0%	0	80.1%	0	80.1%
iREPR_RUBP	1	62.2%	1	46.8%	10	36.0%	1	21.3%
iREPR_NMMP	2	57.5%	1	40.9%	462,841	37.0%	0	75.3%
iREPR_METP	0	0.0%	2	27.4%	2	31.2%	74,511	25.4%
iREPR_CONS	1	-0.3%	0	-0.2%	4,653	-1.9%	145	-5.2%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.8 Production based GHG emissions

Table 66 Production based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.

Industry	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Closing the loop' Industries scenario*	*Percentage change with respect to the baseline ('Closing the loop' scenario)*
iPLNT	95,812	94,660	-1.2%
iANIM	276,727	275,864	-0.3%
iFORE	3,043	2,950	-3.0%
iFISH	5,030	4,993	-0.7%
iFOSM	63,894	63,817	-0.1%
iOTHM	4,504	3,998	-11.2%
iFBTO	36,702	36,557	-0.4%
iTXWO	34,628	32,343	-6.6%
iCOKE	15,344	16,154	5.3%
iREFN	116,278	116,324	0.0%
iCHEM	136,158	125,800	-7.6%
iRUBP	7,679	7,661	-0.2%
iNMMP	174,773	175,591	0.5%
iMETP	167,670	168,698	0.6%
iELEC	5,601	5,485	-2.1%
iMACH	20,874	20,691	-0.9%
iELCF	785,294	789,851	0.6%
iELCG	22,231	22,341	0.5%
iTRDI	55,048	55,173	0.2%
iHWAT	7,696	7,697	0.0%
iWATR	555	563	1.4%
iCONS	50,288	50,363	0.1%
iTRAD	65,774	65,843	0.1%
iHORE	14,408	14,430	0.2%
iTRAN_water	85,777	87,575	2.1%
iTRAN_other	275,199	276,700	0.5%
iREBA	60,225	60,221	0.0%
iRENT	6,789	6,759	-0.4%
iPUBO	96,663	96,496	-0.2%
iWAST	175,217	182,143	4.0%
iRECY	2,131	2,224	4.4%
iREPR_TXWO	5,353	9,004	68.2%
iREPR_RUBP	4,789	7,874	64.4%
iREPR_NMMP	18,173	23,651	30.1%
iREPR_METP	1,643	2,052	24.9%
iREPR_CONS	77	74	-2.8%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.3.9 Consumption based Emissions

Table 67 Consumption based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.The product definition is similar to industry definition.

Product	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Closing the loop' scenario*	*Percentage change with respect to the baseline ('Closing the loop' scenario)*
pPLNT	60,559	59,662	-1.5%
pANIM	82,792	82,703	-0.1%
pFORE	2,949	2,785	-5.6%
pFISH	6,395	6,310	-1.3%
pFOSM	13,296	13,252	-0.3%
pOTHM	1,484	1,250	-15.8%
pFBTO	359,036	356,082	-0.8%
pTXWO	94,239	88,221	-6.4%
pCOKE	1,978	2,011	1.7%
pREFN	193,004	191,196	-0.9%
pCHEM	105,776	102,534	-3.1%
pRUBP	14,969	13,683	-8.6%
pNMMP	29,730	29,693	-0.1%
pMETP	59,452	58,335	-1.9%
pELEC	68,483	67,002	-2.2%
pMACH	299,179	293,572	-1.9%
pELCT	214,559	214,583	0.0%
pTRDI	107,676	107,281	-0.4%
pHWAT	37,114	37,193	0.2%
pWATR	10,656	10,614	-0.4%
pCONS	490,571	487,642	-0.6%
pTRAD	16,946	16,851	-0.6%
pHORE	94,372	93,635	-0.8%
pTRAN_water	10,384	10,373	-0.1%
pTRAN_other	138,900	138,589	-0.2%
pREBA	232,538	229,905	-1.1%
pRENT	5,687	5,609	-1.4%
pPUBO	689,707	672,999	-2.4%
pWAST	85,498	85,249	-0.3%
pRECY	365	375	2.7%
pREPR_TXWO	0	0	90.4%
pREPR_RUBP	0	0	59.7%
pREPR_NMMP	0	0	75.9%
pREPR_METP	0	0	16.1%
pREPR_CONS	0	0	-19.1%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4 Additional result tables: Territory and Sea

B.4.1 Output

Table 68 Industry output in million euro for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Resource Efficiency on Territory and Sea' scenario*	*Percentage change with respect to the baseline ('Resource Efficiency on Territory and Sea' Scenario)*
iPLNT	242,368	242,375	0.0%
iANIM	191,304	191,340	0.0%
iFORE	39,992	39,989	0.0%
iFISH	14,459	16,330	12.9%
iFOSM	75,915	75,893	0.0%
iOTHM	279,950	279,921	0.0%
iFBTO	993,075	993,283	0.0%
iTXWO	890,984	890,867	0.0%
iCOKE	7,379	7,378	0.0%
iREFN	373,483	373,343	0.0%
iCHEM	540,838	540,709	0.0%
iRUBP	342,870	342,800	0.0%
iNMMP	242,179	242,176	0.0%
iMETP	959,590	959,390	0.0%
iELEC	759,602	759,441	0.0%
iMACH	2,483,955	2,483,492	0.0%
iELCF	143,312	143,456	0.1%
iELCG	89,431	89,528	0.1%
iTRDI	407,391	407,428	0.0%
iHWAT	21,612	21,613	0.0%
iWATR	61,785	61,791	0.0%
iCONS	2,253,028	2,253,337	0.0%
iTRAD	1,658,665	1,658,585	0.0%
iHORE	902,568	902,729	0.0%
iTRAN_water	123,939	124,696	0.6%
iTRAN_other	1,771,849	1,771,793	0.0%
iREBA	4,255,127	4,255,065	0.0%
iRENT	289,377	289,373	0.0%
iPUBO	6,976,864	6,976,851	0.0%
iWAST	226,988	226,993	0.0%
iRECY	63,628	63,636	0.0%
iREPR_TXWO	99,172	99,166	0.0%
iREPR_RUBP	86,751	86,742	0.0%
iREPR_NMMP	45,977	45,976	0.0%
iREPR_METP	157,093	157,069	0.0%
iREPR_CONS	7,428	7,429	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.2 Employment

Table 69 Employment in 1000 p for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total employment in 1000 p in 2030 in the baseline*	*Total employment in 1000 p in 2030 in 'Resource Efficiency on Territory and Sea'scenario*	*Percentage change with respect to the baseline ('Resource Efficiency on Territory and Sea' Scenario)*
iPLNT	5,870	5,872	0.0%
iANIM	2,783	2,784	0.0%
iFORE	1,284	1,284	0.0%
iFISH	359	393	9.3%
iFOSM	161	161	0.0%
iOTHM	597	597	0.0%
iFBTO	4,029	4,030	0.0%
iTXWO	5,049	5,049	0.0%
iCOKE	4	4	0.0%
iREFN	241	241	0.0%
iCHEM	2,023	2,022	0.0%
iRUBP	1,231	1,231	0.0%
iNMMP	1,360	1,360	0.0%
iMETP	4,553	4,552	0.0%
iELEC	2,371	2,371	0.0%
iMACH	10,090	10,089	0.0%
iELCF	348	349	0.1%
iELCG	160	160	0.1%
iTRDI	844	844	0.0%
iHWAT	49	49	0.0%
iWATR	302	302	0.0%
iCONS	15,582	15,585	0.0%
iTRAD	30,208	30,208	0.0%
iHORE	9,727	9,729	0.0%
iTRAN_water	306	308	0.5%
iTRAN_other	9,592	9,592	0.0%
iREBA	26,552	26,554	0.0%
iRENT	620	620	0.0%
iPUBO	70,483	70,486	0.0%
iWAST	1,289	1,289	0.0%
iRECY	200	200	0.0%
iREPR_TXWO	610	610	0.0%
iREPR_RUBP	203	203	0.0%
iREPR_NMMP	231	231	0.0%
iREPR_METP	423	423	0.0%
iREPR_CONS	73	73	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.3 Price indices

Table 70 Price indices for 4 EU-regions in 2030. Index equals 1 for all regions in 2011. TS refers to 'Resource Efficiency on Territory and Sea' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*NEU*	*SEU*	*WEU*	*EEU*	*NEU*	*SEU*	*WEU*	*EEU*
	BAU	TS	BAU	TS	BAU	TS	BAU	TS
pPLNT	1.065	1.065	1.083	1.083	1.086	1.086	1.030	1.030
pANIM	1.063	1.063	1.071	1.072	1.081	1.081	1.031	1.031
pFORE	1.084	1.084	1.082	1.082	1.069	1.070	1.017	1.017
pFISH	1.055	0.957	1.067	0.980	1.050	0.923	1.020	0.939
pFOSM	1.102	1.102	1.057	1.057	1.074	1.074	1.003	1.003
pOTHM	1.096	1.096	1.059	1.059	1.049	1.049	1.029	1.029
pFBTO	1.051	1.051	1.064	1.064	1.069	1.069	1.023	1.023
pTXWO	1.051	1.051	1.058	1.058	1.065	1.065	1.010	1.010
pCOKE	1.077	1.077	1.040	1.040	1.039	1.039	1.018	1.019
pREFN	1.068	1.069	1.072	1.072	1.072	1.072	1.014	1.014
pCHEM	1.070	1.070	1.060	1.060	1.070	1.070	1.017	1.017
pRUBP	1.053	1.054	1.057	1.057	1.065	1.066	1.014	1.014
pNMMP	1.055	1.055	1.060	1.060	1.060	1.060	1.017	1.017
pMETP	1.050	1.050	1.053	1.053	1.055	1.055	1.017	1.017
pELEC	1.044	1.045	1.057	1.057	1.057	1.057	1.014	1.014
pMACH	1.045	1.045	1.055	1.055	1.057	1.057	1.016	1.016
pELCT	1.062	1.062	1.074	1.074	1.083	1.083	1.026	1.026
pTRDI	1.062	1.063	1.067	1.068	1.076	1.077	1.029	1.029
pHWAT	1.056	1.056	1.068	1.068	1.068	1.068	1.022	1.022
pWATR	1.053	1.053	1.073	1.073	1.084	1.084	1.011	1.012
pCONS	1.043	1.044	1.062	1.062	1.063	1.063	1.021	1.021
pTRAD	1.049	1.049	1.062	1.063	1.067	1.067	1.016	1.016
pHORE	1.040	1.040	1.074	1.074	1.071	1.071	1.006	1.006
pTRAN_water	1.036	1.031	1.073	1.071	1.068	1.066	1.003	1.001
pTRAN_other	1.054	1.054	1.057	1.057	1.061	1.061	1.014	1.014
pREBA	1.062	1.062	1.079	1.079	1.084	1.084	1.026	1.026
pRENT	1.072	1.072	1.073	1.073	1.096	1.096	1.015	1.015
pPUBO	1.039	1.039	1.063	1.063	1.064	1.064	0.996	0.996
pWAST	1.048	1.049	1.054	1.055	1.073	1.074	1.016	1.017
pRECY	1.067	1.067	1.049	1.049	1.053	1.053	1.020	1.020
pREPR_TXWO	1.042	1.042	1.058	1.058	1.064	1.064	1.015	1.016
pREPR_RUBP	1.082	1.083	1.062	1.062	1.086	1.086	1.014	1.014
pREPR_NMMP	1.037	1.037	1.059	1.059	1.060	1.060	1.016	1.016
pREPR_METP	1.042	1.042	1.052	1.052	1.049	1.049	1.016	1.016
pREPR_CONS	1.021	1.021	1.051	1.039	1.067	1.062	1.020	1.009

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.4 Household expenditures

Table 71 Household expenditures in mln euro of households in EU-27 on product level in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in 'Resource Efficiency on Territory and Sea' scenario*	*Percentage change with respect to the baseline ('Resource Efficiency on Territory and Sea' Scenario)*
pPLNT	97,159	97,150	0.0%
pANIM	45,693	45,698	0.0%
pFORE	11,276	11,275	0.0%
pFISH	10,413	11,714	12.5%
pFOSM	10,183	10,182	0.0%
pOTHM	6,980	6,979	0.0%
pFBTO	704,907	705,063	0.0%
pTXWO	413,956	413,945	0.0%
pCOKE	697	697	0.0%
pREFN	189,465	189,488	0.0%
pCHEM	247,419	247,386	0.0%
pRUBP	55,482	55,483	0.0%
pNMMP	35,761	35,764	0.0%
pMETP	134,048	134,058	0.0%
pELEC	338,093	338,051	0.0%
pMACH	1,552,124	1,551,970	0.0%
PELCT	64,032	64,046	0.0%
pTRDI	157,106	157,136	0.0%
pHWAT	11,070	11,072	0.0%
pWATR	30,130	30,135	0.0%
pCONS	1,742,377	1,742,680	0.0%
pTRAD	209,616	209,654	0.0%
pHORE	686,668	686,865	0.0%
pTRAN_water	11,921	11,979	0.5%
pTRAN_other	430,442	430,493	0.0%
pREBA	2,127,270	2,127,586	0.0%
pRENT	38,820	38,826	0.0%
pPUBO	5,353,519	5,353,666	0.0%
pWAST	88,141	88,159	0.0%
pRECY	1,290	1,290	0.0%
pREPR_TXWO	0	0	0.0%
pREPR_RUBP	0	0	0.0%
pREPR_NMMP	0	0	0.0%
pREPR_METP	0	0	0.0%
pREPR_CONS	0	0	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.5 Production based raw material use (also known as DEU)

Table 72 Production based material use in kilotonnes in 2030 and percentage change in the TS-scenario. TS refers to 'Resource Efficiency on Territory and Sea' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	TS	BAU	TS	BAU	TS	BAU	TS	BAU	TS
iPLNT	537,412	0.0%	1,793	0.0%	423	0.1%	245	0.0%	0	0.0%
iANIM	614,376	0.0%	1,326	0.0%	0	0.0%	11	0.0%	0	0.0%
iFORE	181	0.0%	258,947	0.0%	466	0.0%	151	0.0%	0	0.0%
iFISH	213	6.6%	35	6.6%	0	0.0%	0	0.0%	0	0.0%
iFOSM	135	0.0%	1	0.0%	705,476	0.0%	134	0.0%	0	0.0%
iOTHM	591	0.0%	70	0.0%	1,212	0.0%	3,413,374	0.0%	189,420	0.0%
iFBTO	2,036	0.0%	158	0.1%	359	0.0%	629	0.1%	0	0.0%
iTXWO	311	0.0%	3,235	0.0%	689	0.0%	138	0.0%	1	0.0%
iCOKE	0	0.0%	0	0.0%	76	0.0%	78	0.0%	0	0.0%
iREFN	0	0.0%	0	0.0%	465	0.0%	410	-0.1%	3	0.0%
iCHEM	122	0.0%	25	0.0%	4,116	0.0%	10,251	0.0%	490	-0.1%
iRUBP	16	0.0%	9	0.0%	716	0.0%	168	0.0%	0	0.0%
iNMMP	102	0.0%	0	0.0%	4,072	0.0%	41,933	0.0%	1,788	0.0%
iMETP	50	0.0%	27	0.0%	8,891	0.0%	6,295	0.0%	409	0.0%
iELEC	79	0.0%	0	0.0%	256	0.0%	603	0.0%	37	0.0%
iMACH	275	0.0%	432	0.0%	1,153	0.0%	450	0.0%	25	0.0%
iELCF	60	0.1%	12	0.0%	885	0.1%	91	0.0%	1	0.0%
iELCG	124	0.0%	48	0.0%	2,606	0.0%	580	0.0%	12	0.0%
iTRDI	147	0.0%	41	0.0%	4,900	0.0%	293	0.0%	3	0.0%
iHWAT	619	0.0%	7	0.0%	831	0.0%	15	0.0%	0	0.0%
iWATR	14	0.0%	3	0.0%	0	0.0%	65	0.0%	0	0.0%
iCONS	62	0.0%	405	0.0%	2,081	0.0%	22,780	0.0%	936	0.0%
iTRAD	6,971	0.0%	1,485	0.0%	11,535	0.0%	27,722	0.0%	300	0.0%
iHORE	159	0.0%	412	0.0%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.0%	7	0.4%	0	0.0%
iTRAN_other	748	0.0%	684	0.0%	6,740	0.0%	15,009	0.0%	1,090	0.0%
iREBA	720	0.0%	783	0.0%	500	0.0%	683	0.0%	35	0.0%
iRENT	56	0.0%	5	0.0%	0	0.0%	84	0.0%	0	0.0%
iPUBO	1,024	0.0%	3,350	0.0%	522	0.0%	507	0.0%	0	0.0%
iWAST	3,343	0.0%	486	0.0%	16,600	0.0%	3,233	0.0%	2	0.0%
iRECY	182	0.0%	43	0.0%	22	0.0%	4,450	0.0%	113	0.0%
iREPR_TXWO	131	0.0%	675	0.0%	774	0.0%	189	0.0%	0	0.0%
iREPR_RUBP	24	0.0%	8	0.0%	754	0.0%	6,726	0.0%	1,125	0.0%
iREPR_NMMP	59	0.0%	0	0.0%	1,899	0.0%	0	0.0%	147	0.0%
iREPR_METP	0	0.0%	0	0.0%	2,377	0.0%	2,374	0.0%	0	0.0%
iREPR_CONS	41	0.0%	44	0.0%	55	0.0%	267	0.0%	25	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.6 Consumption based raw material use

Table 73 Consumption based material use in kilotonnes in 2030 and percentage change in the TS-scenario. TS refers to 'Resource Efficiency on Territory and Sea' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	TS	BAU	TS	BAU	TS	BAU	TS	BAU	TS
pPLNT	234,849	0.0%	1,701	0.0%	17,873	0.0%	34,457	0.0%	2,992	0.0%
pANIM	220,255	0.0%	1,767	0.0%	9,172	0.0%	14,986	0.0%	1,566	0.0%
pFORE	879	0.0%	73,258	0.0%	1,734	0.0%	3,285	0.0%	313	0.0%
pFISH	1,199	-1.1%	223	1.1%	2,689	-4.6%	3,436	-5.5%	379	-5.8%
pFOSM	939	0.0%	200	0.0%	127,722	0.0%	3,982	0.0%	447	0.0%
pOTHM	441	0.0%	64	0.0%	1,151	-0.1%	100,459	0.0%	8,093	0.0%
pFBTO	675,626	0.0%	20,879	0.0%	104,234	-0.1%	237,002	0.0%	23,769	-0.1%
pTXWO	37,767	0.0%	58,930	0.0%	44,712	0.0%	97,265	0.0%	11,455	0.0%
pCOKE	97	0.0%	135	0.0%	4,568	0.0%	860	0.0%	92	0.0%
pREFN	11,091	0.0%	1,797	0.0%	441,326	0.0%	66,889	0.0%	10,864	0.0%
pCHEM	18,190	0.0%	3,029	0.0%	55,986	0.0%	164,883	0.0%	14,290	0.0%
pRUBP	2,494	0.0%	1,693	0.0%	7,474	0.0%	23,053	0.0%	2,418	0.0%
pNMMP	2,696	0.0%	366	0.0%	12,417	0.0%	116,295	0.0%	5,656	0.0%
pMETP	5,785	0.0%	1,264	0.0%	25,467	0.0%	193,656	0.0%	27,468	0.0%
pELEC	10,859	0.0%	2,723	0.0%	35,902	0.0%	134,902	0.0%	19,772	0.0%
pMACH	54,168	0.0%	26,271	0.0%	146,897	0.0%	595,996	0.0%	90,657	0.0%
pELCT	4,251	0.0%	1,549	0.0%	71,482	0.0%	25,771	0.0%	3,387	0.0%
pTRDI	7,466	0.0%	1,810	0.0%	139,002	0.0%	50,023	0.0%	5,834	0.0%
pHWAT	1,915	0.0%	680	0.0%	28,465	0.0%	9,287	0.0%	1,248	0.0%
pWATR	1,525	0.0%	265	0.0%	6,741	0.0%	9,523	0.0%	920	0.0%
pCONS	64,587	0.0%	27,492	0.0%	288,364	0.0%	1,607,690	0.0%	129,330	0.0%
pTRAD	3,641	0.0%	577	0.0%	7,523	0.0%	22,106	0.0%	2,725	0.0%
pHORE	92,363	0.0%	5,072	0.0%	46,235	0.0%	75,782	0.0%	7,937	0.0%
pTRAN_water	599	0.0%	54	0.7%	1,363	-4.9%	1,554	0.0%	171	-0.5%
pTRAN_other	14,617	0.0%	7,439	0.0%	71,290	0.0%	73,878	0.0%	7,405	0.0%
pREBA	52,302	0.0%	19,442	0.0%	144,086	0.0%	450,848	0.0%	36,355	0.0%
pRENT	1,057	0.0%	276	0.0%	3,141	-0.1%	6,390	0.0%	850	0.0%
pPUBO	205,899	0.0%	87,660	0.0%	383,299	0.0%	717,205	0.0%	89,405	0.0%
pWAST	7,546	0.0%	1,014	0.0%	19,797	0.0%	35,825	0.0%	3,622	0.0%
pRECY	111	0.0%	13	0.0%	260	0.0%	516	0.0%	60	0.0%
pREPR_TXWO	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
pREPR_RUBP	0	0.0%	0	0.0%	0	-0.1%	0	0.0%	0	0.0%
pREPR_NMMP	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
pREPR_METP	0	0.0%	0	0.0%	0	-0.1%	0	0.0%	0	0.0%
pREPR_CONS	0	-0.6%	0	-0.2%	0	-1.0%	0	-1.1%	0	-0.6%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.7 Production based secondary material use

Table 74 Production based secondary material use in kilotonnes in 2030 and percentage change in the TS-scenario. TS refers to 'Resource Efficiency on Territory and Sea' scenario. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Industry	*Biomass*		*Fossil fuels*		*Non-metalic minerals*		*Metal ores*	
	BAU	TS	BAU	TS	BAU	TS	BAU	TS
iPLNT	11,393	0.0%	0	0.0%	0	0.0%	0	0.0%
iANIM	12,933	0.0%	0	0.0%	0	0.0%	0	0.0%
iFORE	5	0.0%	0	0.0%	0	0.0%	0	0.0%
iFISH	6	6.6%	0	0.0%	0	0.0%	0	0.0%
iFOSM	4	0.0%	1,513	0.0%	0	0.0%	0	0.0%
iOTHM	15	0.0%	1	0.0%	0	0.0%	0	0.0%
iFBTO	52	0.0%	0	0.0%	1	0.1%	0	0.0%
iTXWO	8	0.0%	1	0.0%	0	0.0%	0	0.0%
iCOKE	0	0.0%	0	0.0%	0	0.0%	0	0.0%
iREFN	0	0.0%	1	-0.1%	1	-0.1%	0	0.0%
iCHEM	3	0.0%	17	-0.1%	16	0.0%	1	0.0%
iRUBP	0	0.0%	1	0.0%	0	0.0%	0	0.0%
iNMMP	3	0.0%	3	0.0%	4,299	0.0%	2	0.0%
iMETP	1	0.0%	7	0.0%	5	0.0%	711	0.0%
iELEC	2	0.0%	0	0.0%	0	0.0%	0	0.0%
iMACH	6	0.0%	1	0.0%	0	0.0%	0	0.0%
iELCF	2	0.1%	1	0.1%	0	0.0%	0	0.0%
iELCG	3	0.0%	2	0.1%	0	0.0%	0	0.0%
iTRDI	4	0.0%	11	0.0%	0	0.0%	0	0.0%
iHWAT	11	0.0%	3	0.0%	0	0.0%	0	0.0%
iWATR	0	0.0%	0	0.0%	0	0.0%	0	0.0%
iCONS	2	0.0%	2	0.0%	26	0.0%	1	0.0%
iTRAD	169	0.0%	11	0.0%	38	0.0%	7	0.0%
iHORE	4	0.0%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.4%	0	0.0%
iTRAN_other	17	0.0%	5	0.0%	15	0.0%	2	0.0%
iREBA	17	0.0%	0	0.0%	1	0.0%	0	0.0%
iRENT	1	0.0%	0	0.0%	0	0.0%	0	0.0%
iPUBO	26	0.0%	0	0.0%	1	0.0%	0	0.0%
iWAST	87	0.0%	12	0.0%	3	0.0%	0	0.0%
iRECY	5	0.0%	0	0.0%	6	0.0%	0	0.0%
iREPR_TXWO	3	0.0%	1	0.0%	0	0.0%	0	0.0%
iREPR_RUBP	1	0.0%	1	0.0%	10	0.0%	1	0.0%
iREPR_NMMP	2	0.0%	1	0.0%	462,841	0.0%	0	0.0%
iREPR_METP	0	0.0%	2	0.0%	2	0.0%	74,511	0.0%
iREPR_CONS	1	0.0%	0	0.0%	4,653	0.0%	145	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.8 Production based GHG emissions

Table 75 Production based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.

Industry	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Resource Efficiency on Territory and Sea' scenario*	*Percentage change with respect to the baseline ('Resource Efficiency on Territory and Sea' scenario)*
iPLNT	95,812	95,821	0.0%
iANIM	276,727	276,782	0.0%
iFORE	3,043	3,042	0.0%
iFISH	5,030	4,722	-6.1%
iFOSM	63,894	63,885	0.0%
iOTHM	4,504	4,503	0.0%
iFBTO	36,702	36,711	0.0%
iTXWO	34,628	34,623	0.0%
iCOKE	15,344	15,343	0.0%
iREFN	116,278	116,237	0.0%
iCHEM	136,158	136,128	0.0%
iRUBP	7,679	7,678	0.0%
iNMMP	174,773	174,772	0.0%
iMETP	167,670	167,637	0.0%
iELEC	5,601	5,600	0.0%
iMACH	20,874	20,870	0.0%
iELCF	785,294	785,956	0.1%
iELCG	22,231	22,259	0.1%
iTRDI	55,048	55,054	0.0%
iHWAT	7,696	7,697	0.0%
iWATR	555	555	0.0%
iCONS	50,288	50,293	0.0%
iTRAD	65,774	65,771	0.0%
iHORE	14,408	14,410	0.0%
iTRAN_water	85,777	65,939	-23.1%
iTRAN_other	275,199	275,187	0.0%
iREBA	60,225	60,224	0.0%
iRENT	6,789	6,789	0.0%
iPUBO	96,663	96,663	0.0%
iWAST	175,217	175,223	0.0%
iRECY	2,131	2,131	0.0%
iREPR_TXWO	5,353	5,352	0.0%
iREPR_RUBP	4,789	4,788	0.0%
iREPR_NMMP	18,173	18,173	0.0%
iREPR_METP	1,643	1,643	0.0%
iREPR_CONS	77	77	0.0%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.4.9 Consumption based Emissions

Table 76 Consumption based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.The product definition is similar to industry definition.

Product	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in 'Resource Efficiency on Territory and Sea' scenario*	*Percentage change with respect to the baseline ('Resource Efficiency on Territory and Sea' scenario)*
pPLNT	60,559	60,497	-0.1%
pANIM	82,792	82,766	0.0%
pFORE	2,949	2,938	-0.4%
pFISH	6,395	5,957	-6.9%
pFOSM	13,296	13,291	0.0%
pOTHM	1,484	1,478	-0.5%
pFBTO	359,036	358,347	-0.2%
pTXWO	94,239	93,983	-0.3%
pCOKE	1,978	1,978	0.0%
pREFN	193,004	192,746	-0.1%
pCHEM	105,776	105,623	-0.1%
pRUBP	14,969	14,942	-0.2%
pNMMP	29,730	29,701	-0.1%
pMETP	59,452	59,362	-0.2%
pELEC	68,483	68,323	-0.2%
pMACH	299,179	298,505	-0.2%
pELCT	214,559	214,505	0.0%
pTRDI	107,676	107,608	-0.1%
pHWAT	37,114	37,106	0.0%
pWATR	10,656	10,643	-0.1%
pCONS	490,571	489,768	-0.2%
pTRAD	16,946	16,884	-0.4%
pHORE	94,372	93,935	-0.5%
pTRAN_water	10,384	8,682	-16.4%
pTRAN_other	138,900	137,948	-0.7%
pREBA	232,538	231,582	-0.4%
pRENT	5,687	5,619	-1.2%
pPUBO	689,707	687,629	-0.3%
pWAST	85,498	85,427	-0.1%
pRECY	365	364	-0.2%
pREPR_TXWO	0	0	-0.6%
pREPR_RUBP	0	0	-2.0%
pREPR_NMMP	0	0	-0.4%
pREPR_METP	0	0	-0.5%
pREPR_CONS	0	0	-1.9%

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.5 Additional result tables: Combined scenario

B.5.1 Output

Table 77 Industry output in million euro for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total output in mln euro in 2030 in the baseline*	*Total output in mln euro in 2030 in combined scenarios*	*Percentage change with respect to the baseline (combined scenarios)*
iPLNT	242,368	327,973	35.3%
iANIM	191,304	83,886	-56.2%
iFORE	39,992	34,727	-13.2%
iFISH	14,459	19,973	38.1%
iFOSM	75,915	60,309	-20.6%
iOTHM	279,950	180,407	-35.6%
iFBTO	993,075	885,756	-10.8%
iTXWO	890,984	596,784	-33.0%
iCOKE	7,379	8,119	10.0%
iREFN	373,483	338,915	-9.3%
iCHEM	540,838	431,806	-20.2%
iRUBP	342,870	284,806	-16.9%
iNMMP	242,179	179,260	-26.0%
iMETP	959,590	863,521	-10.0%
iELEC	759,602	637,351	-16.1%
iMACH	2,483,955	2,266,296	-8.8%
iELCF	143,312	107,988	-24.6%
iELCG	89,431	90,413	1.1%
iTRDI	407,391	415,096	1.9%
iHWAT	21,612	22,400	3.6%
iWATR	61,785	61,774	0.0%
iCONS	2,253,028	2,442,849	8.4%
iTRAD	1,658,665	1,647,969	-0.6%
iHORE	902,568	926,939	2.7%
iTRAN_water	123,939	117,806	-4.9%
iTRAN_other	1,771,849	1,758,741	-0.7%
iREBA	4,255,127	4,255,180	0.0%
iRENT	289,377	651,839	125.3%
iPUBO	6,976,864	7,033,237	0.8%
iWAST	226,988	235,614	3.8%
iRECY	63,628	64,214	0.9%
iREPR_TXWO	99,172	257,699	159.9%
iREPR_RUBP	86,751	225,499	159.9%
iREPR_NMMP	45,977	70,595	53.5%
iREPR_METP	157,093	201,909	28.5%
iREPR_CONS	7,428	68,008	815.6%

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B.5.2 Employment

Table 78 Employment in 1000 p for EU-27 in 2030. Industry definition can be found in Table 28.

Industry	*Total employment in 1000 p in 2030 in the baseline*	*Total employment in 1000 p in 2030 in combined scenarios*	*Percentage change with respect to the baseline (combined scenarios)*
iPLNT	5,870	8,260	40.7%
iANIM	2,783	1,320	-52.6%
iFORE	1,284	1,150	-10.4%
iFISH	359	523	45.4%
iFOSM	161	129	-20.2%
iOTHM	597	403	-32.5%
iFBTO	4,029	3,609	-10.4%
iTXWO	5,049	3,476	-31.2%
iCOKE	4	4	10.9%
iREFN	241	221	-8.4%
iCHEM	2,023	1,632	-19.3%
iRUBP	1,231	1,039	-15.6%
iNMMP	1,360	1,033	-24.0%
iMETP	4,553	4,125	-9.4%
iELEC	2,371	2,022	-14.7%
iMACH	10,090	9,360	-7.2%
iELCF	348	252	-27.5%
iELCG	160	179	12.2%
iTRDI	844	899	6.5%
iHWAT	49	54	9.1%
iWATR	302	312	3.5%
iCONS	15,582	17,184	10.3%
iTRAD	30,208	30,454	0.8%
iHORE	9,727	10,203	4.9%
iTRAN_water	306	295	-3.8%
iTRAN_other	9,592	9,685	1.0%
iREBA	26,552	27,233	2.6%
iRENT	620	1,573	153.6%
iPUBO	70,483	72,053	2.2%
iWAST	1,289	1,365	5.9%
iRECY	200	201	0.8%
iREPR_TXWO	610	1,641	168.9%
iREPR_RUBP	203	571	181.5%
iREPR_NMMP	231	368	59.2%
iREPR_METP	423	573	35.4%
iREPR_CONS	73	588	710.3%

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B.5.3 Price indices

Table 79 Price indices for 4 EU-regions in 2030. Index equals 1 for all regions in 2011. CS refers to Combined scenarios. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*NEU*	*SEU*	*WEU*	*EEU*	*NEU*	*SEU*	*WEU*	*EEU*
	BAU	CS	BAU	CS	BAU	CS	BAU	CS
pPLNT	1.065	1.087	1.083	1.144	1.086	1.131	1.030	1.090
pANIM	1.063	1.092	1.071	1.120	1.081	1.116	1.031	1.092
pFORE	1.084	1.130	1.082	1.152	1.069	1.109	1.017	1.083
pFISH	1.055	0.962	1.067	1.023	1.050	0.903	1.020	0.979
pFOSM	1.102	1.145	1.057	1.092	1.074	1.126	1.003	1.070
pOTHM	1.096	1.138	1.059	1.108	1.049	1.075	1.029	1.100
pFBTO	1.051	1.060	1.064	1.092	1.069	1.082	1.023	1.060
pTXWO	1.051	1.052	1.058	1.041	1.065	1.063	1.010	1.012
pCOKE	1.077	1.096	1.040	1.030	1.039	0.939	1.018	0.908
pREFN	1.068	1.088	1.072	1.085	1.072	1.089	1.014	1.047
pCHEM	1.070	1.090	1.060	1.074	1.070	1.082	1.017	1.025
pRUBP	1.053	1.048	1.057	1.041	1.065	1.069	1.014	0.972
pNMMP	1.055	1.047	1.060	1.067	1.060	1.057	1.017	1.012
pMETP	1.050	0.999	1.053	1.005	1.055	1.000	1.017	0.974
pELEC	1.044	1.059	1.057	1.074	1.057	1.076	1.014	1.019
pMACH	1.045	1.032	1.055	1.043	1.057	1.049	1.016	0.997
pELCT	1.062	1.086	1.074	1.130	1.083	1.131	1.026	1.086
pTRDI	1.062	1.008	1.067	1.068	1.076	1.066	1.029	1.031
pHWAT	1.056	1.037	1.068	1.113	1.068	1.048	1.022	1.024
pWATR	1.053	1.063	1.073	1.129	1.084	1.132	1.011	1.057
pCONS	1.043	1.029	1.062	1.078	1.063	1.053	1.021	1.028
pTRAD	1.049	1.104	1.062	1.128	1.067	1.119	1.016	1.107
pHORE	1.040	1.055	1.074	1.125	1.071	1.093	1.006	1.029
pTRAN_water	1.036	1.052	1.073	1.132	1.068	1.105	1.003	1.066
pTRAN_other	1.054	1.084	1.057	1.098	1.061	1.091	1.014	1.058
pREBA	1.062	1.100	1.079	1.152	1.084	1.137	1.026	1.103
pRENT	1.072	1.135	1.073	1.102	1.096	1.141	1.015	1.053
pPUBO	1.039	1.076	1.063	1.124	1.064	1.102	0.996	1.060
pWAST	1.048	1.065	1.054	1.094	1.073	1.112	1.016	1.065
pRECY	1.067	1.104	1.049	1.071	1.053	1.073	1.020	1.052
pREPR_TXWO	1.042	1.072	1.058	1.108	1.064	1.103	1.015	1.061
pREPR_RUBP	1.082	1.138	1.062	1.115	1.086	1.140	1.014	1.064
pREPR_NMMP	1.037	1.061	1.059	1.113	1.060	1.098	1.016	1.060
pREPR_METP	1.042	1.063	1.052	1.065	1.049	1.068	1.016	1.029
pREPR_CONS	1.021	1.044	1.051	1.106	1.067	1.114	1.020	1.062

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 820707.

B.5.4 Household expenditures

Table 80 Household expenditures in mln euro of households in EU-27 on product level in 2030. Industry definition can be found in Table 28. The product definition is similar to industry definition.

Product	*Household expenditures in mln euro in 2030 in the baseline*	*Household expenditures in mln euro in 2030 in combined scenario*	*Percentage change with respect to the baseline (combined scenario)*
pPLNT	97,159	155,756	60.3%
pANIM	45,693	37,142	-18.7%
pFORE	11,276	10,870	-3.6%
pFISH	10,413	11,370	9.2%
pFOSM	10,183	9,656	-5.2%
pOTHM	6,980	4,184	-40.1%
pFBTO	704,907	640,333	-9.2%
pTXWO	413,956	371,207	-10.3%
pCOKE	697	863	23.8%
pREFN	189,465	192,091	1.4%
pCHEM	247,419	248,760	0.5%
pRUBP	55,482	59,333	6.9%
pNMMP	35,761	37,406	4.6%
pMETP	134,048	154,095	15.0%
pELEC	338,093	304,809	-9.8%
pMACH	1,552,124	1,462,188	-5.8%
PELCT	64,032	66,189	3.4%
pTRDI	157,106	168,555	7.3%
pHWAT	11,070	12,194	10.2%
pWATR	30,130	30,275	0.5%
pCONS	1,742,377	1,917,382	10.0%
pTRAD	209,616	212,774	1.5%
pHORE	686,668	724,670	5.5%
pTRAN_water	11,921	11,601	-2.7%
pTRAN_other	430,442	437,917	1.7%
pREBA	2,127,270	2,236,122	5.1%
pRENT	38,820	257,732	563.9%
pPUBO	5,353,519	5,430,688	1.4%
pWAST	88,141	91,495	3.8%
pRECY	1,290	1,283	-0.6%
pREPR_TXWO	0	0	262.5%
pREPR_RUBP	0	0	153.3%
pREPR_NMMP	0	0	168.3%
pREPR_METP	0	0	69.4%
pREPR_CONS	0	0	2252.6%

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B.5.5 Production based raw material use (also known as DEU)

Table 81 Production based raw material use in kilotonnes in 2030 and percentage change in the CS-scenario. CS refers to Combined scenarios. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CS	BAU	CS	BAU	CS	BAU	CS	BAU	CS
iPLNT	537,412	36.6%	1,793	41.1%	423	43.2%	245	28.6%	0	27.4%
iANIM	614,376	-55.8%	1,326	-51.6%	0	0.0%	11	-52.7%	0	0.0%
iFORE	181	-11.8%	258,947	-13.9%	466	-11.8%	151	-11.7%	0	-11.8%
iFISH	213	90.4%	35	90.4%	0	0.0%	0	0.0%	0	0.0%
iFOSM	135	-21.9%	1	-22.0%	705,476	-20.9%	134	-21.2%	0	-22.0%
iOTHM	591	-31.8%	70	-34.7%	1,212	-31.9%	3,413,374	-35.6%	189,420	-30.2%
iFBTO	2,036	-15.5%	158	-14.8%	359	-18.5%	629	-8.2%	0	-9.2%
iTXWO	311	-31.8%	3,235	-36.3%	689	-32.2%	138	-31.1%	1	-31.1%
iCOKE	0	0.0%	0	0.0%	76	9.0%	78	9.3%	0	10.4%
iREFN	0	0.0%	0	0.0%	465	-14.4%	410	-10.0%	3	-15.1%
iCHEM	122	-20.9%	25	-21.4%	4,116	-17.0%	10,251	-17.6%	490	-14.8%
iRUBP	16	-12.1%	9	-11.9%	716	-11.9%	168	-17.9%	0	-20.0%
iNMMP	102	-23.7%	0	0.0%	4,072	-22.5%	41,933	-24.6%	1,788	-24.4%
iMETP	50	-13.0%	27	-14.1%	8,891	-14.0%	6,295	-13.7%	409	-14.1%
iELEC	79	-16.1%	0	-16.1%	256	-16.3%	603	-16.1%	37	-16.1%
iMACH	275	-9.1%	432	-9.3%	1,153	-8.5%	450	-8.3%	25	-8.3%
iELCF	60	-33.6%	12	-34.5%	885	-32.4%	91	-34.5%	1	-34.5%
iELCG	124	38.3%	48	39.7%	2,606	38.4%	580	39.7%	12	39.7%
iTRDI	147	8.3%	41	8.3%	4,900	6.9%	293	7.9%	3	8.3%
iHWAT	619	1.7%	7	9.5%	831	3.5%	15	9.5%	0	9.5%
iWATR	14	4.3%	3	4.3%	0	4.3%	65	4.3%	0	4.3%
iCONS	62	9.3%	405	8.8%	2,081	9.5%	22,780	8.1%	936	8.0%
iTRAD	6,971	-0.1%	1,485	-0.5%	11,535	-0.9%	27,722	-1.7%	300	-1.4%
iHORE	159	6.6%	412	6.6%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	0.0%	7	-13.1%	0	0.0%
iTRAN_other	748	0.3%	684	0.4%	6,740	0.0%	15,009	-0.6%	1,090	-1.3%
iREBA	720	1.3%	783	2.0%	500	2.4%	683	2.4%	35	2.4%
iRENT	56	264.9%	5	266.2%	0	0.0%	84	262.6%	0	266.2%
iPUBO	1,024	2.7%	3,350	1.5%	522	2.9%	507	0.7%	0	2.9%
iWAST	3,343	5.1%	486	4.3%	16,600	5.1%	3,233	5.9%	2	5.1%
iRECY	182	-1.5%	43	5.5%	22	-1.6%	4,450	-3.6%	113	-1.6%
iREPR_TXWO	131	203.5%	675	232.4%	774	203.6%	189	203.5%	0	203.5%
iREPR_RUBP	24	208.1%	8	208.2%	754	201.2%	6,726	117.5%	1,125	73.0%
iREPR_NMMP	59	119.6%	0	0.0%	1,899	101.6%	0	0.0%	147	147.6%
iREPR_METP	0	0.0%	0	0.0%	2,377	56.5%	2,374	59.4%	0	0.0%
iREPR_CONS	41	1278.2%	44	1786.7%	55	877.7%	267	1361.6%	25	1818.7%

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B.5.6 Consumption based raw material use

Table 82 Consumption based raw material use in kilotonnes in 2030 and percentage change in the CS-scenario. CS refers to Combined scenarios. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Product	*Biomass*	*Biomass*	*Wood*	*Wood*	*Fossil Fuels*	*Fossil Fuels*	*Non-metallic minerals*	*Non-metallic minerals*	*Metal ores*	*Metal Ores*
	BAU	CS	BAU	CS	BAU	CS	BAU	CS	BAU	CS
pPLNT	234,849	70.6%	1,701	75.2%	17,873	26.4%	34,457	23.3%	2,992	4.1%
pANIM	220,255	-19.8%	1,767	-21.6%	9,172	-40.6%	14,986	-42.0%	1,566	-42.4%
pFORE	879	-11.0%	73,258	-3.8%	1,734	-31.0%	3,285	-39.4%	313	-39.8%
pFISH	1,199	-14.7%	223	-16.6%	2,689	-34.8%	3,436	-38.0%	379	-37.5%
pFOSM	939	-8.6%	200	-5.8%	127,722	-2.9%	3,982	-30.2%	447	-33.5%
pOTHM	441	-38.1%	64	-47.3%	1,151	-54.3%	100,459	-44.5%	8,093	-42.7%
pFBTO	675,626	-19.0%	20,879	-11.4%	104,234	-32.7%	237,002	-32.7%	23,769	-34.9%
pTXWO	37,767	-31.6%	58,930	-21.0%	44,712	-42.6%	97,265	-46.9%	11,455	-53.0%
pCOKE	97	7.6%	135	21.2%	4,568	-16.2%	860	-17.7%	92	-20.1%
pREFN	11,091	-2.0%	1,797	-3.1%	441,326	1.4%	66,889	-18.7%	10,864	-16.6%
pCHEM	18,190	57.7%	3,029	121.7%	55,986	-28.7%	164,883	-30.5%	14,290	-35.4%
pRUBP	2,494	-14.2%	1,693	0.6%	7,474	-32.9%	23,053	-35.1%	2,418	-44.5%
pNMMP	2,696	-4.5%	366	-10.7%	12,417	-10.4%	116,295	-24.0%	5,656	-28.0%
pMETP	5,785	-16.3%	1,264	-15.4%	25,467	-24.1%	193,656	-24.8%	27,468	-36.2%
pELEC	10,859	-24.1%	2,723	-33.8%	35,902	-34.6%	134,902	-42.4%	19,772	-43.6%
pMACH	54,168	-25.5%	26,271	-24.0%	146,897	-38.3%	595,996	-44.5%	90,657	-47.2%
pELCT	4,251	3.7%	1,549	17.3%	71,482	-12.6%	25,771	-21.0%	3,387	-21.3%
pTRDI	7,466	-5.9%	1,810	-3.9%	139,002	-24.4%	50,023	-25.0%	5,834	-28.5%
pHWAT	1,915	4.9%	680	0.4%	28,465	-9.1%	9,287	-20.8%	1,248	-22.1%
pWATR	1,525	-3.8%	265	-8.8%	6,741	-21.3%	9,523	-34.0%	920	-34.3%
pCONS	64,587	-16.2%	27,492	-22.0%	288,364	-22.7%	1,607,690	-44.5%	129,330	-40.8%
pTRAD	3,641	0.8%	577	-4.7%	7,523	-18.7%	22,106	-11.0%	2,725	-9.9%
pHORE	92,363	-12.0%	5,072	-9.3%	46,235	-16.1%	75,782	-23.1%	7,937	-23.9%
pTRAN_water	599	5.6%	54	-2.9%	1,363	-18.0%	1,554	-20.6%	171	-9.3%
pTRAN_other	14,617	0.6%	7,439	-0.4%	71,290	-21.5%	73,878	-15.9%	7,405	-16.3%
pREBA	52,302	-3.0%	19,442	-15.7%	144,086	-15.5%	450,848	-14.8%	36,355	-21.0%
pRENT	1,057	580.6%	276	520.7%	3,141	479.2%	6,390	557.9%	850	559.5%
pPUBO	205,899	-9.6%	87,660	-11.5%	383,299	-29.0%	717,205	-31.6%	89,405	-34.0%
pWAST	7,546	1.3%	1,014	-7.0%	19,797	-14.1%	35,825	-25.7%	3,622	-25.3%
pRECY	111	-2.2%	13	-8.1%	260	-21.0%	516	-16.1%	60	-22.3%
pREPR_TXWO	0	122.5%	0	224.7%	0	151.8%	0	140.1%	0	149.1%
pREPR_RUBP	0	140.5%	0	165.9%	0	152.5%	0	122.0%	0	113.2%
pREPR_NMMP	0	52.8%	0	137.9%	0	72.0%	0	34.5%	0	112.6%
pREPR_METP	0	-9.2%	0	41.0%	0	6.8%	0	9.6%	0	-0.8%
pREPR_CONS	0	1420.9%	0	3116.6%	0	1531.1%	0	2314.9%	0	2833.2%

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B.5.7 Production based secondary material use

Table 83 Production based secondary material use in kilotonnes in 2030 and percentage change in the CS-scenario. CS refers to Combined scenarios. BAU refers to Business-as-Usual Baseline. Industry definition can be found in Table 28.

Industry	*Biomass*		*Fossil fuels*		*Non-metalic minerals*		*Metal ores*	
	BAU	CS	BAU	CS	BAU	CS	BAU	CS
iPLNT	11,393	37.7%	0	52.6%	0	28.3%	0	27.4%
iANIM	12,933	-55.4%	0	0.0%	0	-52.7%	0	0.0%
iFORE	5	-11.8%	0	-11.8%	0	-11.7%	0	-11.8%
iFISH	6	90.4%	0	0.0%	0	0.0%	0	0.0%
iFOSM	4	-21.9%	1,513	-20.3%	0	-21.1%	0	-22.0%
iOTHM	15	-31.6%	1	-31.9%	0	0.0%	0	0.0%
iFBTO	52	-15.6%	0	-18.5%	1	-7.5%	0	-9.1%
iTXWO	8	-31.8%	1	-35.2%	0	-31.1%	0	-31.1%
iCOKE	0	0.0%	0	8.4%	0	9.3%	0	10.4%
iREFN	0	0.0%	1	-12.4%	1	-10.1%	0	-15.1%
iCHEM	3	-20.9%	17	-15.1%	16	-17.8%	1	-17.0%
iRUBP	0	-12.1%	1	-12.0%	0	-18.9%	0	-20.0%
iNMMP	3	-23.7%	3	-22.5%	4,299	-25.9%	2	-24.2%
iMETP	1	-13.0%	7	-13.4%	5	-13.4%	711	-10.3%
iELEC	2	-16.1%	0	-16.7%	0	-16.1%	0	-16.1%
iMACH	6	-9.0%	1	-8.9%	0	-8.3%	0	-8.4%
iELCF	2	-33.9%	1	-24.1%	0	-34.5%	0	-34.5%
iELCG	3	38.7%	2	30.8%	0	39.7%	0	39.7%
iTRDI	4	8.3%	11	4.7%	0	7.6%	0	8.3%
iHWAT	11	1.8%	3	0.4%	0	9.5%	0	9.5%
iWATR	0	4.3%	0	4.3%	0	4.3%	0	4.3%
iCONS	2	9.3%	2	9.4%	26	7.9%	1	8.5%
iTRAD	169	-0.2%	11	-1.0%	38	-1.9%	7	-2.1%
iHORE	4	6.6%	0	0.0%	0	0.0%	0	0.0%
iTRAN_water	0	0.0%	0	0.0%	0	-13.1%	0	0.0%
iTRAN_other	17	0.3%	5	0.0%	15	-0.9%	2	-1.2%
iREBA	17	1.5%	0	2.4%	1	2.4%	0	2.4%
iRENT	1	264.9%	0	0.0%	0	261.5%	0	266.2%
iPUBO	26	2.8%	0	2.7%	1	0.7%	0	2.5%
iWAST	87	5.1%	12	5.1%	3	6.3%	0	5.1%
iRECY	5	-1.5%	0	-1.6%	6	-4.3%	0	-1.6%
iREPR_TXWO	3	203.5%	1	204.6%	0	203.5%	0	203.5%
iREPR_RUBP	1	208.1%	1	166.7%	10	123.2%	1	94.1%
iREPR_NMMP	2	119.7%	1	101.6%	462,841	69.3%	0	139.2%

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B.5.8 Production based GHG emissions

Table 84 Production based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.

Industry	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in combined scenario*	*Percentage change with respect to the baseline (combined scenario)*
iPLNT	95,812	111,569	16.4%
iANIM	276,727	118,674	-57.1%
iFORE	3,043	1,818	-40.3%
iFISH	5,030	4,049	-19.5%
iFOSM	63,894	50,272	-21.3%
iOTHM	4,504	2,611	-42.0%
iFBTO	36,702	22,420	-38.9%
iTXWO	34,628	16,061	-53.6%
iCOKE	15,344	12,064	-21.4%
iREFN	116,278	105,261	-9.5%
iCHEM	136,158	71,710	-47.3%
iRUBP	7,679	4,553	-40.7%
iNMMP	174,773	112,367	-35.7%
iMETP	167,670	103,623	-38.2%
iELEC	5,601	3,279	-41.5%
iMACH	20,874	13,261	-36.5%
iELCF	785,294	572,417	-27.1%
iELCG	22,231	22,551	1.4%
iTRDI	55,048	39,921	-27.5%
iHWAT	7,696	5,625	-26.9%
iWATR	555	394	-29.1%
iCONS	50,288	38,015	-24.4%
iTRAD	65,774	45,331	-31.1%
iHORE	14,408	10,286	-28.6%
iTRAN_water	85,777	44,178	-48.5%
iTRAN_other	275,199	189,271	-31.2%
iREBA	60,225	41,798	-30.6%
iRENT	6,789	7,397	9.0%
iPUBO	96,663	67,541	-30.1%
iWAST	175,217	175,106	-0.1%
iRECY	2,131	1,507	-29.2%
iREPR_TXWO	5,353	9,779	82.7%
iREPR_RUBP	4,789	9,550	99.4%
iREPR_NMMP	18,173	24,262	33.5%
iREPR_METP	1,643	1,509	-8.2%
iREPR_CONS	77	650	749.3%

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B.5.9 Consumption based Emissions

Table 85 Consumption based GHG emissions in kilotonnes in 2030. Industry definition can be found in Table 28.The product definition is similar to industry definition.

Product	*GHG emissions in kton CO_2-eq in 2030 in the baseline*	*GHG emissions in kton CO_2-eq in 2030 in combined scenario*	*Percentage change with respect to the baseline (combined scenario)*
pPLNT	60,559	83,395	37.7%
pANIM	82,792	62,399	-24.6%
pFORE	2,949	2,017	-31.6%
pFISH	6,395	4,131	-35.4%
pFOSM	13,296	12,513	-5.9%
pOTHM	1,484	728	-50.9%
pFBTO	359,036	216,549	-39.7%
pTXWO	94,239	53,275	-43.5%
pCOKE	1,978	1,693	-14.4%
pREFN	193,004	191,312	-0.9%
pCHEM	105,776	74,957	-29.1%
pRUBP	14,969	9,959	-33.5%
pNMMP	29,730	26,106	-12.2%
pMETP	59,452	44,545	-25.1%
pELEC	68,483	43,218	-36.9%
pMACH	299,179	178,569	-40.3%
pELCT	214,559	182,204	-15.1%
pTRDI	107,676	79,012	-26.6%
pHWAT	37,114	38,234	3.0%
pWATR	10,656	8,892	-16.6%
pCONS	490,571	350,444	-28.6%
pTRAD	16,946	13,186	-22.2%
pHORE	94,372	70,698	-25.1%
pTRAN_water	10,384	6,896	-33.6%
pTRAN_other	138,900	104,859	-24.5%
pREBA	232,538	185,058	-20.4%
pRENT	5,687	32,821	477.1%
pPUBO	689,707	497,476	-27.9%
pWAST	85,498	81,964	-4.1%
pRECY	365	297	-18.6%
pREPR_TXWO	0	0	125.7%
pREPR_RUBP	0	0	104.1%
pREPR_NMMP	0	0	89.3%
pREPR_METP	0	0	-8.0%
pREPR_CONS	0	0	1330.3%

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